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VARIABLE SPEED TRANSMITTERS.

THREE NEW DEVICES FOR THE POSITIVE TRANSMISSION OF VARIABLE SPEED.

In the transmission of power the requirements are frequently such as to make necessary a variable speed transmitter for changing the speed of the driven shaft, or follower, relative to the speed of the driver. For this purpose cones and belts have generally been made to answer the requirements, or when it was desired to transmit the power more positively, nests of gears of different diameters have been employed with suitable devices for throwing into mesh any one of several pairs of gears, to give the desired speed changes.

There are many cases, however, where it is desirable either to obtain minute gradations in the speed or to change the speed gradually without shock or jar while the mechanism is in operation. A large number of patents have been taken out on devices for accomplishing these ends. Among these are cones with shifting belts and innumerable modifications of the revolving disc with a friction roll so arranged that the roll can be located at any point on the face of the disc, and in this way change the velocity ratio of the parts. There are also many belt-driven devices designed so that the driving and driven pulleys can be expanded or contracted to give the effect of larger or smaller pulleys, as desired.

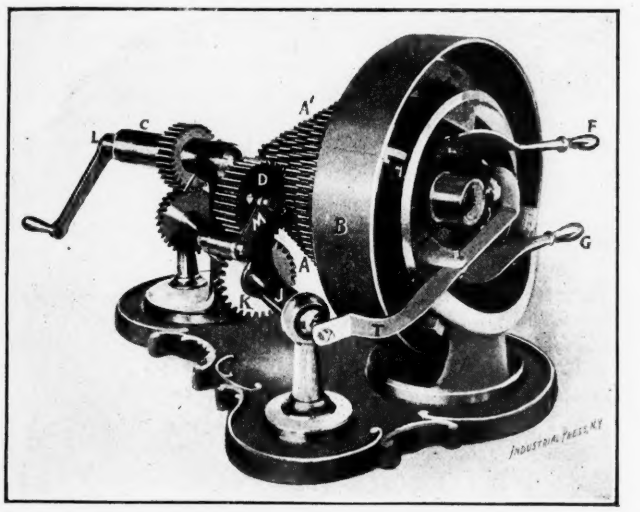


Fig. 1. Model of Shattuck Mechanism.

Until recently, however, there has been no patent issued in the United States for a positive motion transmitter, giving small gradations in the speed and a gradual change from one speed to the next one. The numerous friction devices do not transmit the power positively, and, while nests of gears have a positive action, they do not, as ordinarily constructed, increase or decrease the speed gradually from one speed to the next. The desideratum in a variable speed device would appear to be one with a wide range in speeds, with gradual change from one speed to the next, and one that would be, withal, of good design mechanically.

The problem of *positive* variable speed transmission is not easy of solution, but it is of increasing importance, partly because of the extensive use of constant-speed electric motors, partly because of the development of the automobile industry, and for other reasons of minor importance. The descriptions which follow, therefore, of three new variable speed devices having positive action, will be of general interest. Each is an attempt to solve the problem in a different way. One is by an ingenious arrangement of gearing, whereby there is no sudden jump in the speed from one step to the next; the second is by variable-throw eccentrics on the driving shaft, which operate clutch mechanisms on the driven shaft; and the third is an arrangement of linkages to give the required speed variation. The latter is the Dieterich motion, which was first described in STEAM ENGINEERING, published by the INDUSTRIAL PRESS, publishers of MACHINERY, and while a description has since appeared in some other papers, it will doubtless be new to most of our readers.

VARIABLE SPEED WITH GEARING.

The problem of making changes in gearing ratios for varying speeds in power transmission, without interruption of the power or shock to the gears, has been rendered feasible by the Shattuck variable gearing. A general view of a model of the Shattuck gearing is shown in Fig. 1, and Figs. 2 and 3 show the details of the device, as well as the method of shifting the gears.

The principle involved in this device is to move a transmitting pinion along the face of a nest or cone of gears arranged in steps and to mesh with anyone of them while the machine is in motion; and, further, to do it without shock or sudden change of speed. The cone, or step, gear is divided longitudinally in the two parts, *A* and *A′*, one half, *A*, being rigidly fastened to the shaft, and the other half, *A′*, being arranged with the guides and slides, *E E*, Figs. 2 and 3, so as to be capable of a limited diagonal motion along its mate, *A*. The proportion of the steps of the cone of gears is so adjusted, and the direction of slant of the guides is such that when the half *A′* of the cone is shifted on the guides, as it is shown in Fig. 2, all its steps on one side will coincide with the steps of the next higher order on the other half, *A*, while the opposite edges of the halves are entirely separated.

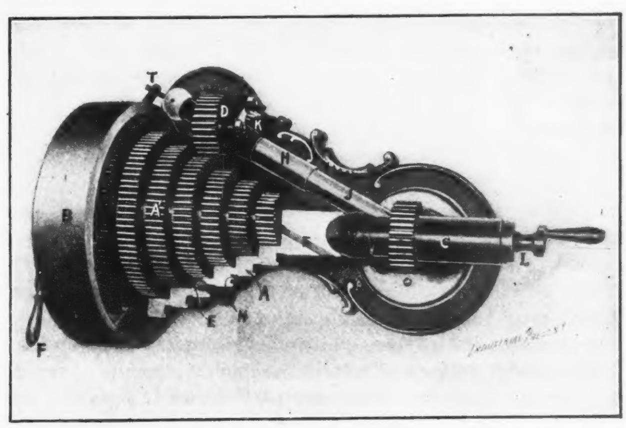


Fig. 2. Top View.

The shifting of the gear ratios is accomplished by moving the movable half, *A′*, so that the pinion *D*, which meshes with the cone, is run upon a different step than it was previously engaged with, after which the movable half is shifted back to its normal position, carrying the pinion D with it and thus keeping it engaged with the new step. The pinion *D* and the spiral gear *K*, with which it meshes, are mounted upon the feathered sleeve *H*, which rotates with and is capable of sliding along the shaft *J* so as to allow the pinion *D* to engage with any step of the cone. In order that the pinions *D* and *K* will shift along positively as the cone-half *A′* moves back to position, their frame, *M*, Fig. 1, has a tongue or shoe that fits and slides in the undercut grooves, *N*, Figs. 1 and 2, of the cone steps. This tongue and groove also serves to hold the pinion *D* automatically to the proper pitch line on any step, or when shifting. The cone-half *A′*

is shifted for changing gears by a mechanism shown at the left in Fig. 3. The cam shoe *R* attached to an extension of the movable cone-half *A'*, slides normally in the groove between the fixed plates *O* and *P;* but when it is desired to shift the cone, one of the switch points, *S* or *S'*, in the groove is shifted by the handle *F* momentarily to direct the cam shoe into a side groove, which draws the movable cone-half to its extreme travel in that direction. The cam shoe will then slide over in that side groove for one-half revolution during which the pinion is set for a change of gear, at the end of which the shoe is automatically directed back into the normal running groove, thus shifting the half-cone back to its normal position. The throwing of the handle has nothing to do but to momentarily throw the switch points in the groove, and the shifting of the gearing takes place automatically after that, so that it may be seen that it requires no skill to handle and is thus universally applicable.

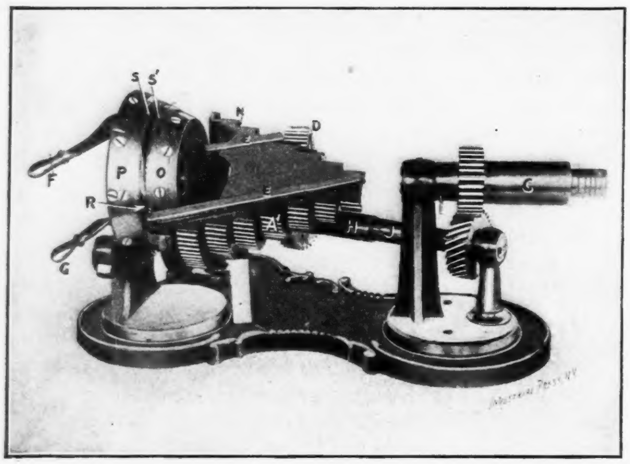


Fig. 3. View showing Model with Half the Gearing Removed.

The model is shown with a belt pulley, *B*, Figs. 1 and 2, mounted upon the gear cone shaft, and the geared transmission is delivered through the pinions *D* and *K* and the shaft *I* to the sleeve *C*, which rotates on the shaft *L*. However, this construction is not essential, and it is probable that it will be modified greatly in certain applications. The gear is not liable to injury by throwing the pinion, *D*, entirely off the gear cone, as it is provided with a safety lever attachment, *I*, Figs. 1 and 2, which prevents further shifting of the pinion than the highest and lowest steps.

The operation of shifting the pinion *D* to another step takes place as follows: The movable cone *A'* is shifted either up or down, as it is desired to transfer the pinion to a lower step or higher step, by a quick movement of the lever *F*, which deflects either point *S* or *S'*, and guides the cam shoe, attached to the movable cone half, to the left or right. This shifting of the movable half-cone directs the pinion *D* onto the lower or higher step, and then at the end of that half revolution the end of the side groove is met, which switches the cam shoe *R* back out into the normal groove, carrying the half-cone back to normal position where it remains until the speed is again changed. From this it may be seen that the change of gear ratio takes place when the movable half cone is switched back to normal position carrying the pinion *D* with it, as it is here that the pinion *D* is carried over to a different diameter of pitch circle. The change takes place gradually so that any shock or jar is impossible. If the device is to be run in only one direction, only one of the levers *F-G* need be used, but with both levers it is adaptable to motion in either direction.

This device was developed in view of its application to automobiles, but if it proves practicable in that service it will have an extensive field of application to the feeds and speeds of machine tools. It was invented by William P. Shattuck, Minneapolis, Minn., and the patents are controlled by the Shattuck Mfg. Co.

SHIFTING ECCENTRIC MECHANISM.

In Fig. 4 is an illustration of a model of a variable speed transmitting gear of the variable throw type that is now on exhibition at Buffalo. It is the invention of Edward and Frank Heymann, Boston, Mass., and is designed to give a speed variation ranging between 5½ revolutions of the driven shaft for one of the driving shaft for the fastest speed and 250 revolutions of the driving shaft to one of the driven, for the slowest speed. The direction of rotation of the driven shaft may also be changed at will so that when used as a transmitting gear for automobiles it is not necessary to reverse the motor or to use an additional reversing motion for backing.

The device has two shafts, one above the other, and the upper one of which has variable throw eccentrics that give a reciprocatory motion to clutches on the lower or driven shaft; and these clutches in turn impart a rotary motion to the driven shaft. The eccentric shaft is hollow and has three squared portions, with the sides of each at an angle of 120 degrees with the corresponding sides of the adjacent section. The eccentrics are steel discs having oblong holes which fit the squared portions of the shaft and are free to slide upon them in a direction crosswise to the axis of the shaft. The shifting of the eccentrics is accomplished by a wedge bar which slides within the hollow shaft, in connection with two keys attached to the eccentric discs, one at each end of the oblong hole. The keys pass through slots in the squared portions of the shaft in order to bear against the central wedge. These keys serve simply for shifting the eccentrics, the rotary motion being transmitted through the flats on the shaft.

There are roller bearings between the eccentrics and their straps to reduce the friction and provision is also made for taking up the wear of these bearings. The eccentric rods connect with reversible roller clutches on the lower shaft, the reversing being accomplished by means of a shaft sliding within the clutch shaft. This shaft has three positions, ahead, neutral and reverse, and when driving in one direction motion is transmitted from one shaft to the other through

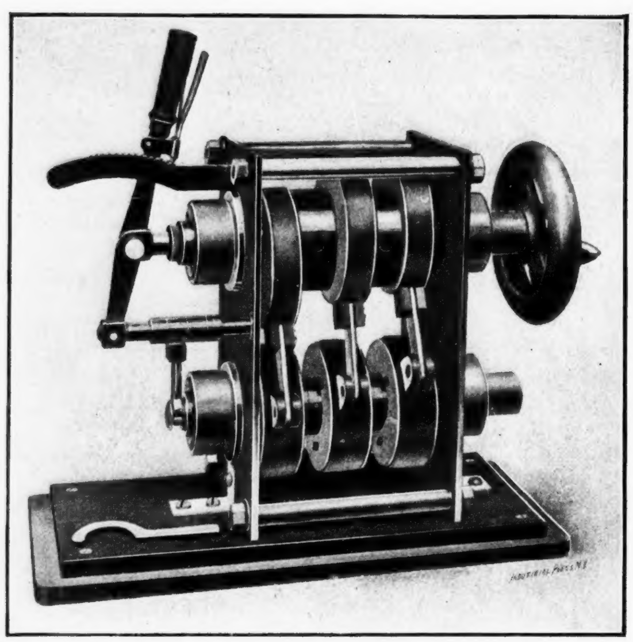


Fig. 4. Model of Heymann Mechanism.

a pull in the eccentric rods; in the reversal the clutches operate in the opposite direction and the eccentric rods exert a push upon the clutches when the latter clutch the shaft.

The wedge bar controlling the positions of the eccentrics may be operated either by a handle, as in the illustration, or by an automatic governor. Three or four eccentrics are provided according to the amount and character of work to be done. The device is mounted in an oil-tight and dust-proof case, the shafts run in roller bearings, and all parts are automatically lubricated. While it may be objected that this is not a positive variable speed device owing to the fact that dependence is placed on a roller clutch, it gives in effect a positive motion. It is possible to design a roller clutch which will grip as tight as any device which is absolutely positive from a theoretical standpoint. This device, moreover, is representative of a distinct type of variable speed devices

which should be classed with those giving in effect a positive motion.

TRANSMITTER WITH LINK MECHANISM.

What is said to have been the first positive variable speed transmitter ever patented in the United States is that invented by L. M. Dieterich, Hartford, Conn. This involves still another principle in that the variation in speed is obtained through a system of linkages, and although the element of friction enters into this device, as in the previous one, it is in effect a positive mechanism.

The idea in its simplest form is illustrated in Figs. 5 and 6. In Fig. 5 the end view shows the driving disc *A* mounted on a shaft whose end is shown in section and in side view at *G* in Fig. 6. The disc is driven in the direction indicated by

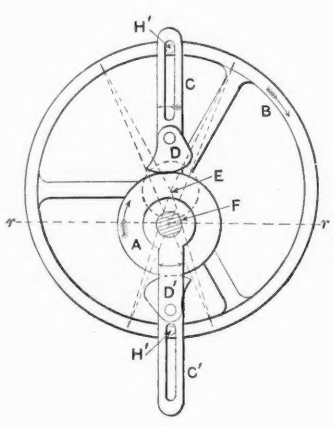


Fig. 5.

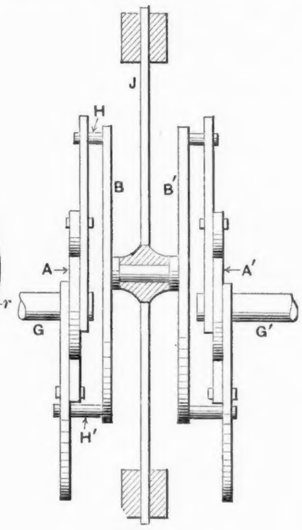


Fig. 6

the arrow and tends to drive the arms *C C'* through the cam-shaped pieces *D D'*, since these cams lock against the periphery of the disc under certain conditions to be explained. The arms *C C'* are slotted to engage the pins *H H'* set in the rim of the wheel *B*. With the center *E* of *B* coinciding with the center *F* of the disc *A*, it is evident that both cams will lock against the periphery of the disc and drive both arms

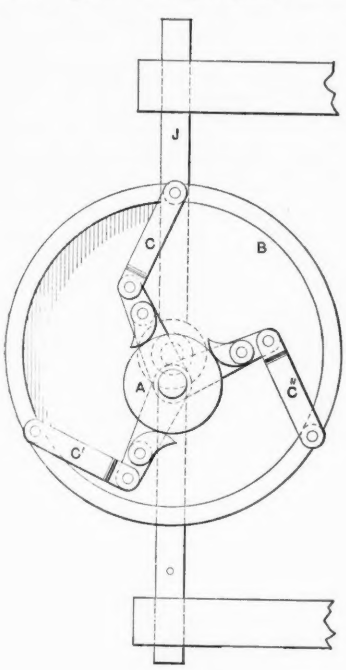


Fig. 7.

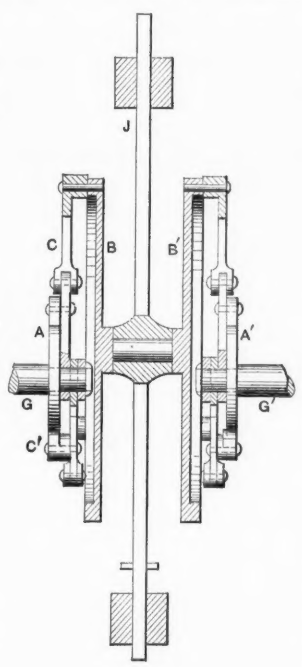


Fig. 8.

and consequently *B* at the same angular velocity as that of *A*. If, however, *B* is shifted upwards, provision being made for this as clearly shown in Fig. 6, the cam *D* will drive its arm *C*, and consequently the wheel *B*, at a faster rate than *A* turns. The consequence is that the cam *D'* does not and cannot drive since it will be carried along at a faster rate than the disc *A* and thus tends to move in an opposite direction to that needed to lock it against the disc *A*. This condition continues until the arms *C C'* have moved around one-quarter of a turn from that shown and coincide with the dotted line *r r*. Then cam *D* automatically unlocks and cam *D'* engages, since it is then beginning to travel at slower rate, and continues in engagement with the disc *A* for one-half of one turn, when the conditions are again reversed. In this manner a greater angular movement is given *B* than that of *A*, depending upon the eccentricity of the two centers *E* and *F*. As already pointed out when these centers coincide, the angular movement is the same, and it changes in proportion to the degree of eccentricity of *E* relative to *A*. It is evident that the motion transmitted to *E* is not of uniform character, the unevenness depending on the degree of eccentricity. To correct this fault, a duplicate of the mechanism just described is provided, shown at the right in Fig. 6, which is set so that its fastest periods correspond to the slowest periods of the first and thus change the character of the motion to one of uniform rate. In the first member, the disc *A* is the driver and *B* is driven; in the duplicate member, *B'* is the driver and *A'* is driven and thus transmits the motion to the shaft *G'*. The sliding piece *J* carrying the shaft of *B* and *B'* is provided for varying the degree of eccentricity. In the illustrative model just described, it is found that while the motion can be made of nearly uniform character with only two transmitting arms, it is better to use three arms. In an operative mechanism of this kind it is also evident that

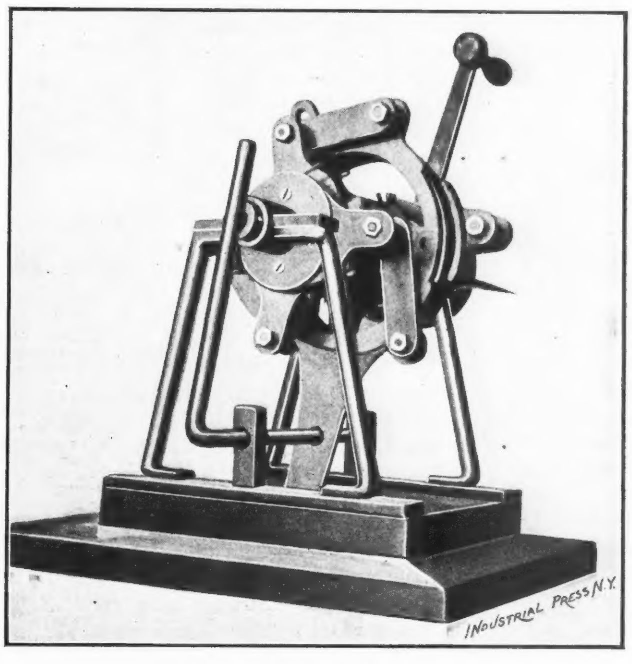


Fig. 9. Model of Dieterich Mechanism.

slotted arms working on pins or even rollers would be the source of large losses in transmission on account of the friction. The two slotted arms are, therefore, discarded for three toggle-joint arms *C C' C''*, Fig. 7, which operate in about the same manner as already described, but make uniform motion possible with a minimum of friction loss.

In the perfected device, cams like those shown in the cuts, are not used, but other devices of a nature depending somewhat on the use to which the transmitter is to be adapted.

A photograph of a model is reproduced in Fig. 9 which gives an idea of the appearance, but not of the compactness of which the device is capable. For convenience in explanation the model is so made that it combines both the straight slotted arms on one side for one member and toggle-joint arms on the other side for the second member.

When used on bicycles or automobiles the device can be made to adapt itself to the load automatically and the eccentricity of the driving and driven parts to shift so that in the case of the bicycle the rider is enabled to pedal with the same pressure whether climbing hills or riding on the level. With automobiles, while it is desirable to have the control instantly possible, it is also desirable to have a device which may be arranged to take care of the power automatically according to the nature of the roads.

CASEHARDENING.

PROCESSES THAT ARE USED - SAMPLES OF WORK BY THE AMERICAN CARBURIZING CO.

The art of casehardening metals of the iron class is one of considerable antiquity, yet it is one not very well understood or appreciated by many who would greatly profit by its use if they were well acquainted with its economic possibilities. There appears to be very little information available on the subject from any published works, presumably because it has been regarded as simple or of comparative unimportance. If the latter view has been taken, it is an erroneous one, judging from the many inquiries we have received asking for information.

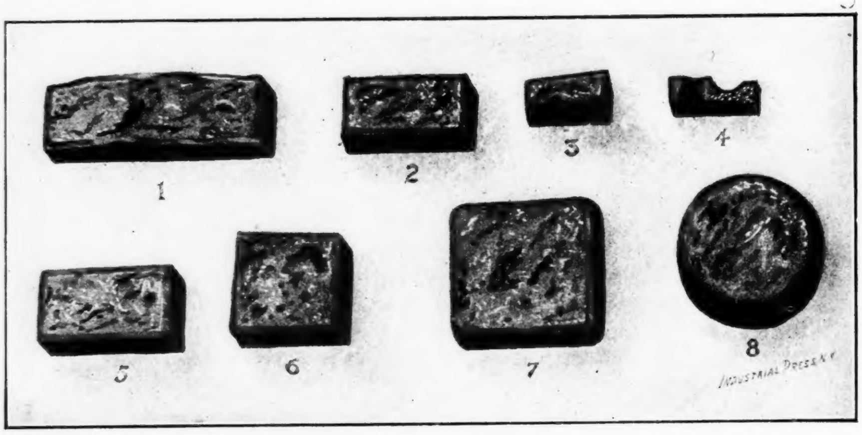
Casehardening is regarded by metallurgists as being primarily a cementation process in which carbon is added to the outer shell of metal and chemically combined with it, making steel. The addition of the carbon causes the outer shell to harden when heated to a bright red and quenched in water. As is generally known, carbon is the principal constituent which makes the difference between the physical structure of wrought iron and that of cast iron and steel. Wrought iron contains little or no carbon. Cast iron contains carbon, but in a segregated or uncombined form. Steel contains carbon chemically combined with the metal. Soft gray iron may contain as much as 3.5 per cent. of uncombined graphitic carbon and from 0.12 to 0.30 per cent (12-100 to 30-100 of 1 per cent) chemically combined. Cast iron having 2 per cent of uncombined carbon and 1½ per cent of combined carbon is known as white cast iron and is so hard as to be unworkable with ordinary tools. Steel may have percentages of carbon ranging from, say, 0.05 per cent for basic Bessemer steel to 1½ per cent for the high-grade crucible steel used in razors. The first quality of steel cannot be hardened by simply heating and dipping, but the addition of sufficient carbon to raise it to, say, 0.70 per cent will enable it to be hardened sufficiently for many purposes. This is what the casehardening process does for malleable iron, wrought iron and low-carbon steel. It adds sufficient carbon to the outer shell to cause it to harden when quenched in cold water. The thickness of the shell depends on the size of the pieces and the time given to the cementation or acieration process. Nitrogen also plays an important part in the process and is always present in all casehardening compounds, usually in the form of ammonia (NH_3).

For superficial casehardening where a thickness of hard shell of only about 1-100 inch is required, potassium cyanide (CNK) also called cyanide of potassium or cyanide of potash, is used. The articles to be hardened may be heated in an open fire to a bright red and then coated with the cyanide, the workman being careful to avoid breathing the poisonous fumes. After the piece is well smeared with the cyanide, it is again heated and then quenched in clear cold water. A better method of using the cyanide, is to heat it in a wrought iron pot to a red and keep it at this temperature. The articles should be immersed from three to five minutes, depending on the size and depth of casehardening wanted. Remove and plunge in water if the bath is at the proper temperature for hardening. If not, reheat and then plunge.

Potassium ferrocyanide ($K_4Fe''Cy_6$) is also used in about the same manner. It is commonly called prussiate of potassium or yellow prussiate of potash. Cast iron may be casehardened by heating and covering it with a composition of equal parts of yellow prussiate of potash, sal-ammoniac and saltpeter, all pulverized and thoroughly mixed together. When the article has been well covered with the compound, dip into a solution of 2 ounces of prussiate of potash and 4 ounces of sal-ammoniac to one gallon of water. Probably equally as good results will be obtained by dipping in clear water as far as hardening goes. The solution may tend to prevent cracking and warping, which is quite likely to occur with cast iron.

The above methods of casehardening give superficial results only and are only employed on small articles which quickly heat and which only require a surface hardness. When considerable depth of hardening is required, especially on large pieces, it is necessary to pack them in a box surrounded by some carburizing material and to heat the box in a furnace for a period ranging from three to thirty hours, depending on the material used and the size of the pieces. A great variety of carburizing substances are used, mostly of animal origin, such as bone dust, charred leather, animal charcoal, hoof parings, horn, ammoniated compounds, soot, etc. The choice of compound should of course be made with reference to the cost of the material and the time required for the process.

Before the advent of the Bessemer steel process, iron rails were used on railways with most unsatisfactory results because of the softness of the iron, which made them wear



SAMPLES OF WORK CASEHARDENED BY THE AMERICAN CARBURIZING COMPANY.

1. Time, ten hours; casehardening, 1-8 in. deep; size, 8 in. long, 2 in. wide and 5-8 in thick.
2. Time, six hours; depth of casehardening, 1-16 in.; size, 8 in. long, 1 1-4 in. wide and 5-8 in. thick.
3. Section of friction ring, 4 in. diameter, 3-4 in. wide and 5-16 in. thick. Time, ten hours; depth of casehardening, 1-16 in. Large quantity done in cast iron pot 24 in. diameter and 20 in. high; bright orange heat.
4. Ball race 2 in. diameter, 7-8 wide and 1-4 in. thick. Time, three hours; depth of casehardening, 1-32 in.; orange heat.
5. Time, eight hours; depth of casehardening, 3-32 in.; size same as No. 2.
6. Time, nine hours; depth of casehardening, 3-32 in.; size, 8 in. long by 1 in. square; material, wrought iron.
7. Time, twelve hours; depth of casehardening, 1 8 in.; size, 8 in. long by 1 5-16 square.
8. Time, eight hours; depth of casehardening, 1-16 in.; size, 1 1-4 in diameter.

Samples 1, 2, 3, 4, 5, 7 and 8 were machinery steel of .12 to .14 carbon. Samples 1, 2, 5, 6, 7 and 8 all packed in boxes 10 in. x 12 in. x 4 in.; walls, 1-2 in. thick. Boxes cooled down, pieces reheated in open fire and quenched. Furnace heat, bright orange.

rapidly and pound out of shape. Some of the English railways followed the practice of casehardening their iron rails, the depth of the casehardening ranging up to one-fourth inch. In Dodd's patent furnace, which was specially designed for this work, the rails were packed in charcoal, lime, and potash in the proportion of 9 parts of charcoal to one each of the lime and potash. The carbonization varied from 0.25 to 0.86 per cent carbon, depending on the time allowed. When the rails were removed from the furnace, they were covered with sand and allowed to cool slowly. It would appear from this that the rails were sufficiently hardened by the carbonization process, without dipping, the exterior portion being similar to the ordinary steel rails now used.

An excellent casehardening has been obtained by treating the articles with a mixture of rasped leather or horn with arsenious acid dissolved in hydrochloric acid. Another casehardening compound is made from albumin ($C_{72}H_{112}N_{18}SO_{22}$) and magnesium sulphate ($MgSO_4 + 7H_2O$) in the proportion of 100 pounds of albumin to 15 pounds of the magnesium sulphate. The ingredients require to be well dried and pulverized and thoroughly mixed together. It is used in a muffle and requires from 12 to 48 hours' heat in a furnace. Azotized animal matter, that is, horns, hoofs, bones, hair, etc., treated with nitric acid and mixed with potassium carbonate (CO_2OK_2) gives off abundant quantities of potassium ferrocyanide when heated in a furnace. Consequently articles packed in such a compound would absorb carbon and nitrogen and harden when dipped. The Krupp and Harvey armor plate hardening process is essentially one of casehardening carried to considerable depth.

There are other compounds on the market for casehardening which have been developed by long and careful experimenting, and which give superior results than bone dust and similar substances when the cost and time are considered. It has been demonstrated that a compound of certain case-hardening materials in certain proportions may be much more effective than the same ingredients in other proportions. Just why this is true is not well understood. The chemical action which takes place in casehardening is probably not as simple as has been assumed. One of the well-known compounds of this nature is that manufactured by the American Carburizing Company, Jersey City, N. J. In the course of the experiments made by Mr. Engler it was demonstrated that a slight variation in the proportions would make a decided change in the efficiency of the material and time required. It weighs about two-thirds as much as bone dust and requires one-third to one-half the time in the furnace. The accompanying photographs give the appearance of the fractured ends of pieces of different material and the time required to caseharden.

The pieces to be casehardened are packed in cast iron boxes of a size suitable to the pieces. For small work to be done in large quantities, 12 x 24 x 12 inches is a convenient size. Where small pieces are to be done a few at a time, the boxes should be as small as will accommodate them with a thickness of carburizer around them about one-half inch thick. The boxes should be made of a quality of cast iron which resists heat well, such as a good quality of stove plate. They are cast open at the top and should have a wall thickness of ½ to ¾ inch. When a box is charged, it is filled full of the articles to be hardened, carefully packed with the carburizing material so that no two pieces shall touch and so that no pieces shall come nearer the sides of the box than about one-half inch. Of course, with small articles, they may be placed closer than this distance if great care is taken that none actually touch the sides. If any articles touch one another or the sides of the box, they will not be carburized at the point of contact and are quite likely to fuse fast and be spoiled.

The open top is covered with pieces of sheet metal, say ⅛ inch thick, cut so as to nicely fill the opening, and then the edges are luted with fire-clay to make the box as nearly air-tight as possible. They may be heated economically in a coal or coke furnace where large quantities of work are being done. There are furnaces on the market specially designed for this class of work. There are also gas furnaces which are well adapted to this class of work, especially where small quantities are being done at a time. The gas furnaces heat quickly and require very little attendance, which more than offsets the extra fuel cost over the coke or coal furnace.

The boxes should be kept at a uniform temperature as nearly as possible during the time they remain in the furnace. The temperature recommended is that commonly known as orange or somewhat higher, if the cast-iron boxes will stand the heat. There is little or no danger of harming steel pieces while packed in carburizing material, since they are protected from the atmosphere and gain carbon instead of losing it, as is the case in an open fire. When the boxes have been in the furnace such a time as experience has demonstrated to be proper, they are hauled out carefully, since cast iron is quite fragile at high temperatures, and the whole contents dumped into a receptacle containing water. It is the usual practice to have a wire screen suspended in the water and counterbalanced so that the articles may be raised to the furface when cooled without "fishing" for them at the bottom. Another method recommended by the American Carburizing Company and which has been found preferable in many cases, is to pull out the boxes and store them where they will cool down slowly. Then, when entirely cold, the pieces are removed and reheated in an open fire to the proper temperature (cherry for small pieces and a bright cherry for large pieces) and then dipped in clear cold water.

Sometimes it is desirable to caseharden a portion of a piece and leave part of it soft. This may be accomplished in a number of ways. The pieces may be packed in the usual manner and the portions to be soft covered with cast iron turnings, clay, sand or any refractory material which will exclude the fumes of the carburizer from the metal. Another method which is quite successful in the case of finished articles, is to thinly electroplate the piece with copper, polish off the parts to be hardened and then caseharden in the usual manner. The copper plated portions will be unaffected and soft while the remainder will be casehardened. Another plan is to turn and finish a piece to size where it is to be hard and leave the portions to be soft, considerably larger than the finish size. After the piece has been carbonized, it is allowed to cool slowly the same as in annealing. The oversize parts are then turned to size and the piece heated and quenched. That part which was turned will be soft because the carbonized metal has been removed. This scheme is employed in fitting such machine parts as locomotive pins which require a hard working surface but which should be soft in the taper parts fitted in the rocker and in the thread at the end.

The practical advantage of casehardening is that pieces requiring a hard exterior may have a soft and tough interior and be less likely to breakage. In the case of bicycle cups and cones it has been found by experience that low-carbon steel when casehardened is better material than crucible steel. The working surfaces may be left glass-hard while the interior will be tough and unlikely to break. When made from high-carbon steel it is necessary to draw the temper after hardening in order to prevent breakage, consequently the working surface is softer than with casehardening. Again a cheaper material may be used which is a decided advantage, especially on large parts. Wrought iron is much easier machined than high-carbon steel, and is cheaper. The working surfaces may be casehardened and answer all practical requirements. The links used on the valve motion of locomotives are well-known examples of casehardened wrought iron construction.

Another feature about casehardening is that low-carbon steel may be successfully employed in the manufacture of metal-cutting tools. The Schenectady Locomotive Works make many large milling cutters from machinery steel, and caseharden the teeth. The cutters are considerably cheaper in first cost than if made from crucible steel, they are said to be less likely to be broken in the hardening process and stand the work fully as well.

* * *

WORK ACCOMPLISHED UPON A HORIZONTAL BORING MACHINE.

The Detrick & Harvey Machine Co., Baltimore, Md., have sent us several photographs, reproduced on P. 6, of their universal horizontal drilling, boring and milling machine operating upon the frame of a traction engine. These illustrations are of interest in showing to what an extent it is possible to increase the range of a standard machine by a study of the conditions to be met. The machine proper is simply a horizontal floor boring machine in which the boring bar is carried by a saddle capable of sliding up or down on a vertical column. Provision is made for an outer support for the bar when the character of the work requires it. In these respects it is similar to any well designed boring machine.

Its universal feature comes from the adoption of a tilting and swiveling table, and the addition of feed mechanism to the saddle and column so that a milling cutter may be used on the end of the boring bar. The fact that the table both swivels and tilts makes it possible to adjust it to any angle with the base plate between 90 and 180 degrees.

The traction engine frame illustrated required nine operations, including boring, milling and drilling. Part of the faces to be finished were at an angle with the center line of the engine, and the casting was completed without changing its setting, all movements being made in the machine itself.

The operation of boring as shown in Fig. 1 is done with an ordinary boring bar, furnished with a head carrying several tools. The outer end of the bar is carried on a bearing on the base plate, to secure greater rigidity. Two cuts are taken at this chucking, the latter with a coarse feed.

With the work in the same position, the seat for the cylinder is faced and the holes for securing the same are drilled. The top of the table is then rotated one quarter of a revolu-

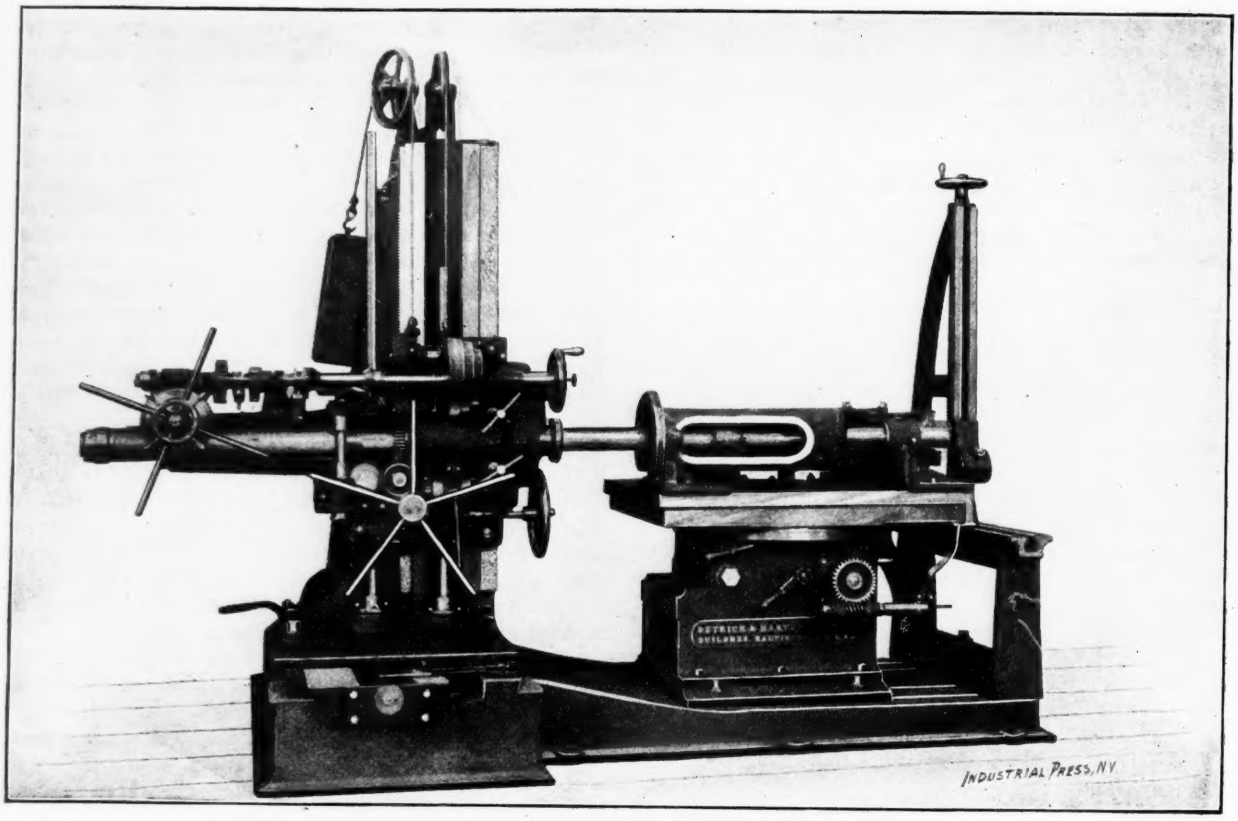
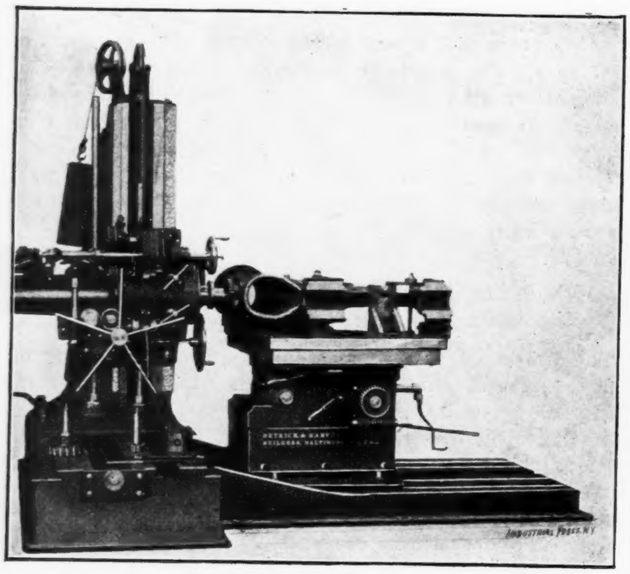
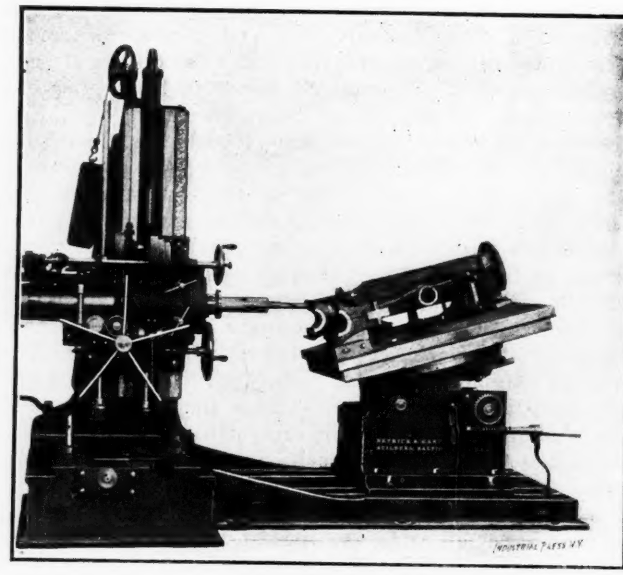
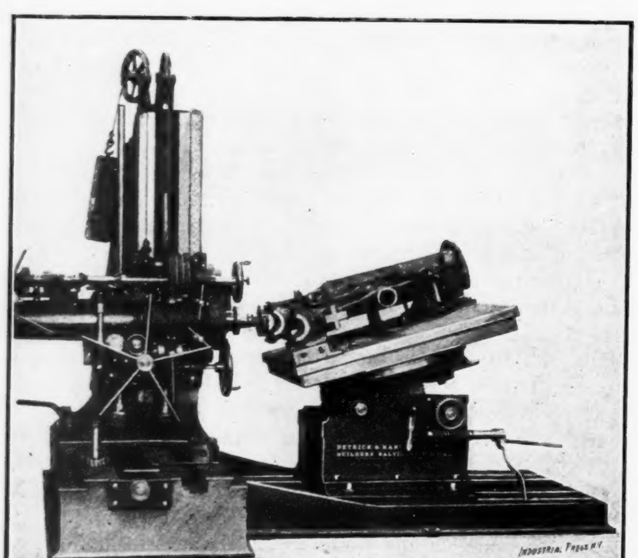
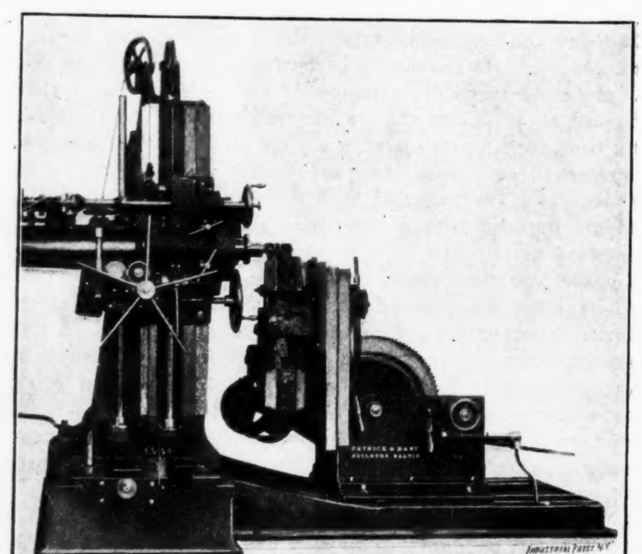


Fig. 1. Horizontal Boring, Drilling and Milling Machine.









Figs. 2 and 3. **Figs. 4 and 5.**

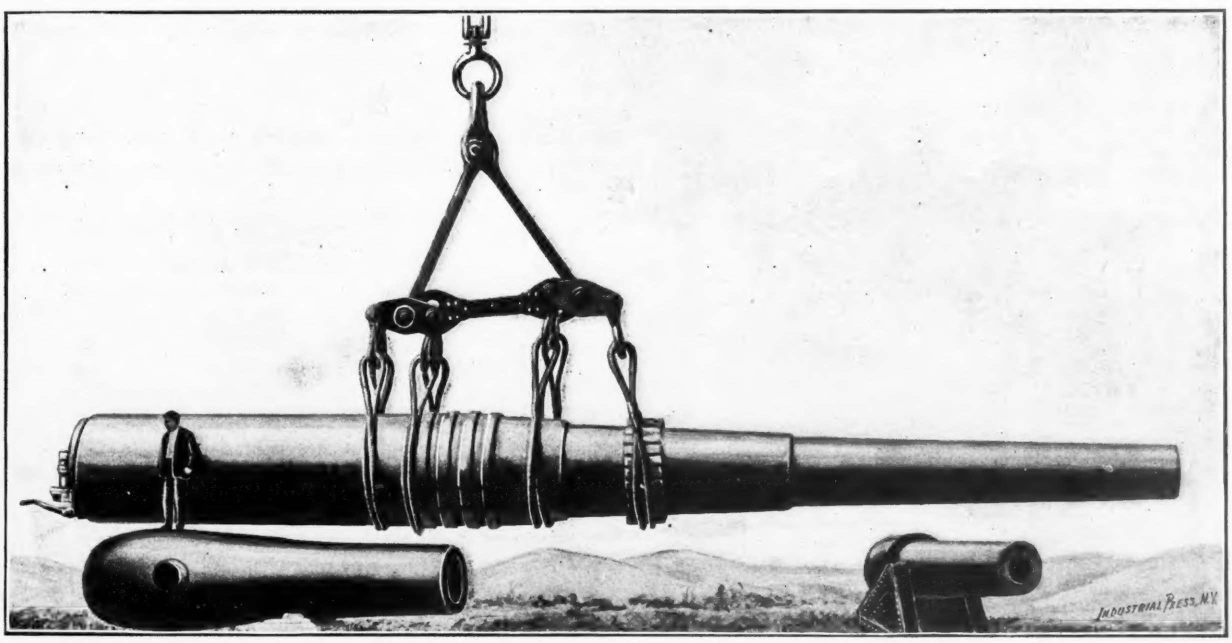
MACHINING THE FRAME OF A TRACTION ENGINE.

tion, the work being in the position shown in Fig. 2. The side, top and bottom edges of the frame opening are milled, the milling being done with an inserted tooth end mill, and a slabbing mill.

The top of the table is again rotated one-quarter of a revolution and tilted to the proper angle, as shown in Fig. 3. The seats for the crank caps are milled with an inserted end mill, after which the stud holes are drilled and tapped in the same position, as shown in Fig. 4.

The top of the table is then rotated back one-quarter of a revolution and tilted into an upright position, as shown in Fig. 5. Here the seats for attaching the frame of the boiler are milled with a gang of mills, and the holes drilled for the bolts, this operation not being shown.

The top of the table is then thrown back into a horizontal position, and the faces of the bearings for crankshaft are finished with a bar and facing heads—the outer end of the bar being carried in the outer support bearing, shown in Fig. 1. The work complete required about eight hours, and was accomplished entirely without special tools or fixtures, with the exception of the plate on which the frame is chucked. One of these machines is on exhibition at Buffalo, as has previously been noted in these columns. It has a spindle 3 7-16 inches in diameter, with a traverse of 24 inches. The saddle has a vertical movement of 40 inches, and the column a horizontal traverse of 40 inches.



20-inch Rodman Smoothbore. Weight 116,000 Lbs. Projectile Round Shot 1,000 Lbs. 16-inch B. L. Rifle. Weight 358,400 Lbs. Projectile 2,370 Lbs. 300-pounder 10-inch Parrott Rifle, Weight 26,000 Lbs. Projectile, 300 Lbs.

The 16-inch Gun Compared with those of Fifty Years Ago.

THE LARGEST GUN.

ONE OF THE RECENT NOTABLE PRODUCTS OF THE MACHINE SHOP.

A report has been made by Col. J. P. Farley, Ordnance Department, U. S. A., upon the 16-inch rifle recently completed for coast defense. This report was printed in the *Journal of the U. S. Artillery*, and for the following points of interest and the photograph from which our cut is made we are indebted to the *Engineering News*, in which an abstract of the report was published.

This 16-inch rifle is a type gun, the first of a series intended for seacoast defense. While guns of larger caliber have been constructed—such as the 17.76-inch Italian gun, the 16.5-inch French gun and the 16.25-inch Armstrong gun for battleships, none of these compare in energy and range with this new 16-inch American gun. With smokeless powder this latter gun requires a charge of 576 pounds; and with a maximum powder pressure of between 37,000 and 38,000 pounds to the square inch, it is estimated that this gun will throw a 2,370-pound projectile, with a muzzle velocity of 2,300 feet per second, and a muzzle energy of 88,000 foot-tons. By using a slower burning powder, it is believed that a greater energy and velocity can be developed. In comparison with this estimate, the Italian gun imparted to a 2,000-pound projectile a muzzle velocity of 1,700 feet per second, and a muzzle energy of only 40,000 foot-tons. The French gun used a 1,700-pound projectile, with a muzzle velocity of 1,700 feet per second and a muzzle energy of 36,000 foot-tons. The English projectile weighed 1,800 pounds, and the velocity was 2,100 feet per second, and the energy 51,000 foot-tons at the muzzle. Expressed in percentages, with the American gun representing 100, the maximum energy of the Italian gun was 45 per cent, that of the French gun 41 per cent, and the English gun 65 per cent.

The projectile for the American gun will be 5 feet 4 inches long; and it would penetrate, at the muzzle, 42.3 inches of steel. The range is estimated at about 21 miles; and in making this range the shell would reach a maximum elevation of 30,516 feet, or nearly 5.8 miles.

The total length of this gun is 49 feet 2.9 inches, with a rear diameter of 60 inches, gradually diminishing to 28 inches at the muzzle. The length of the main bore is 37 feet 4.5 inches, with a diameter of 16 inches.

This 16 inch gun is built up as follows, the hoops being designated by letters according to usual custom: The tube is 566.5 inches long, with an outside diameter of 29.3 inches. Two C-hoops are shrunk over the tube from the forward end of the jacket to the muzzle. The jacket is 304.65 inches long, and is shrunk on the rear portion of the tube from the end of the C-hoop; this jacket overhangs the rear end of the tube for 24.4 inches and forms the breech recess. The D-hoop is 144.5 inches long, and is shrunk over the forward end of the jacket and rear part of the C-hoop. Its bore contains two locking shoulders, which grip over two corresponding shoulders on the jacket and C-hoop, and thus prevent the sliding backward of the jacket, or forward of the C-hoops. Three A-hoops are next shrunk on; the A^1 overlaps the rear part of the D-hoop with its front end, and the outer surface of the jacket with its rear end; hoops A^2 and A^3 are shrunk directly over the jacket. The B-hoops will be shrunk outside of the A-hoops, and their form depends on the style of mount finally adopted—a detail not yet fully determined. For the same reason the full weight of the finished gun cannot be given, though this can be estimated from some of the finished weights of parts. The total finished weights of these parts are 248,030 pounds. The probable finished weight of the gun will be 358,400 pounds. The modified estimate of 1891 calls for a completed gun weighing 130 tons, from forgings which in the rough were to weigh 375 tons.

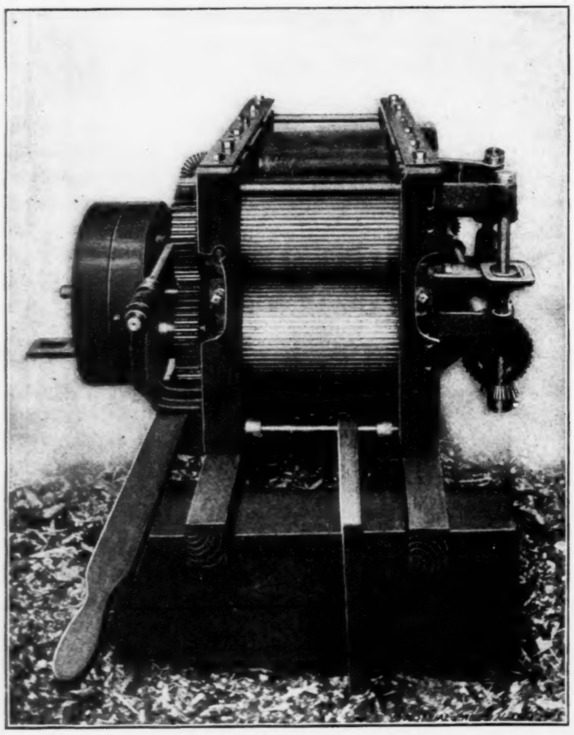
The special tools for making this gun were contracted for in 1894, and three boring and turning lathes, designed at the

Watervliet Arsenal, were made by the Pond Machine Tool Co., of Plainfield, N. J. These lathes were 138 feet long, with a swing of 9 feet, and each lathe weighed 280 tons. To facilitate transportation the bed of the lathe was built in six separate sections. The 12-inch gun-lathe was used for a turning-lathe, and the rifling-machine was extended in length and fitted for the 16-inch gun. A 150-ton traveling crane was made for this work by the Morgan Engineering Co., of Alliance, O. Instructions for manufacturing this 16-inch type gun were dated January 26, 1897, and the first forging for this gun was received at the Arsenal on February 19, 1898. In all, eleven especial machines and tools were purchased or refitted for making these 16-inch guns, the majority of them being made by the Pond Machine Tool Co.

* * *

CELLULOSE MACHINES.

In the April issue of MACHINERY a brief mention was made of the great value of cellulose as a packing between the outer and inner walls of war vessels, on account of its capacity to absorb water and swell up sufficiently to close the openings if the plates are pierced below the water line by shots from the enemy, and to the effect that the best cellulose is made from cornstalks. Mr. W. E. Willis, Harrisburg, Pa., has sent us the photograph, reproduced herewith, of a machine for the purpose of separating the cellulose, or pith, from the cornstalk, and also some interesting facts connected therewith.



Machine for Separating Pith from Cornstalks.

Maize, or Indian Corn, is, as is well known, regarded as a profitable crop by farmers throughout this country. It is used as a food for cattle, either chopped up fine while green, in which condition it is known as "ensilage," or after it is ripened and dry, although they will not, even though very hungry, eat the portion containing the pith, which is a wise provision of nature on account of the entire absence of nutriment in the pith, and besides its inevitable absorption of the juices of their stomachs, which would injure their digestion. When separated from the stalk, however, the pith has considerable value as a bedding for cattle, packing for crockery and fragile articles, and in the manufacture of hats and fancy ornaments. And, as the grain, leaves, husks, and even the cobs, have definite commercial values, it may be seen that if the proper separation of the pith from the stalk could be made, a saving of the entire ripened crop could be effected.

The separation of the pith from the stalk is not an easy matter on account of the irregular structural arrangements of corn stalks, besides their varying diameters and lengths. It is accomplished in the machine illustrated, however, in a very ingenious manner, which renders it independent of all irregularities of size and shape. In it, the entire plant as it is cut and hauled from the field is operated upon, the butts of the stalks entering foremost, and its first operation is that of nipping off the ears of corn and delivering them free from the rolls. The ears are further taken care of by being husked by an arrangement not shown. The stalks passing into the machine enter the large rolls shown and are crushed flat, causing them to split open on the edges, which reduces the stalks whether large or small to a condition in which the shell is disposed on the top and bottom layer while the pith portion is between. Then a rapidly reciprocating knife, lying in the plane of the flattened stalks as they are issuing from the rolls, and close to and slightly above the middle of the opening between the rolls, shears, or splits off, the top layer, while the lower layer and pith pass on to a second set of rolls and reciprocating knife, where a like operation is performed on the lower side of the stalk. Finally, means are provided for cutting both the shell and the pith, separately, into short lengths, together with the necessary conveyors to properly deliver the products. It may thus be seen that the entire stalk is made use of, the pith being extracted and the shell, which has value as a fodder equal to the best hay, is chopped up ready for the cattle.

The capacity of the machine shown, which is twelve inches wide, is about twenty tons of stalks per day of ten hours, one-tenth of which represents the pure cellulose. In bulk, however, the cellulose represents about one half of the stalks, as the pith resumes its normal size and shape, like rubber, after being freed from the compression of the rolls.

For use as packing between the inner and outer walls of war vessels, this pith is treated chemically to make it fireproof and is then pressed into shape for use. Experiments tried upon it under the conditions of such service have proven it capable of entirely stopping up holes below the water line by its swelling action.

* * *

NEW FITCHBURG LATHES AT THE WORKS OF THE FORE RIVER ENGINE CO.

In the June number of MACHINERY was published a description of the new works of the Fore River Engine Co., of Quincy Point, Mass. At the time the article was written the works were not fully equipped with tools, and the photographs from which our illustrations were made were taken before some of the most important machines were in place. In the main machine shop the most striking feature is a row of five 60-inch lathes designed for turning and boring nickel-steel forgings, such as crank and propeller shafts, connecting rods, and other large forgings necessary in the construction of heavy marine machinery. These lathes were built and installed by the Fitchburg Machine Works, Fitchburg, Mass., and are shown in the general view of one end of the Fore River Engine Co.'s machine shop, which appears in Fig. 2. A larger view of one of the lathes appears in Fig. 3, and in Fig. 1 is shown the row of five headstocks with their motor equipment.

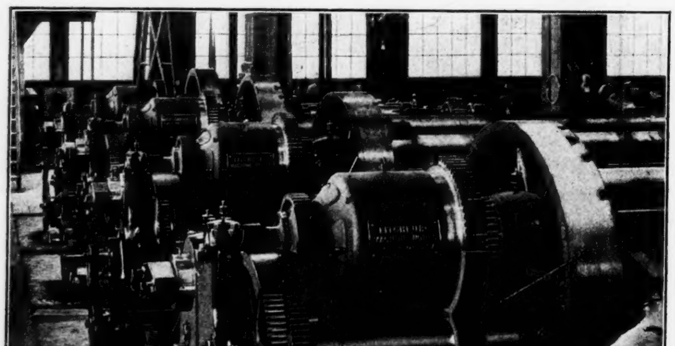


Fig. 1. Row of Headstocks.

These lathes are designed to turn pieces 45 feet long between centers, and two of the lathes have boring bar-bed extensions, making a total length of 113 feet. In designing the machines the manufacturers have made no radical change in the operating parts usual with first-class lathes of this size.

The new designs and patterns were made for the purpose of providing a very heavy, powerful lathe, in which all the parts would be able to do their full share of the work. The net weight of each lathe is 97,000 pounds, and the metal is carefully distributed, while to meet modern requirements for heavy tools electric drive has been provided.

motor five changes of speed, and the motor can be run in either direction by turning the crank forward or back, as desired. With the multiple-voltage system a variable speed is obtained without a waste of power in resistances in the armature circuit, as the controller supplies the different voltages directly from their sources to meet the varying conditions.

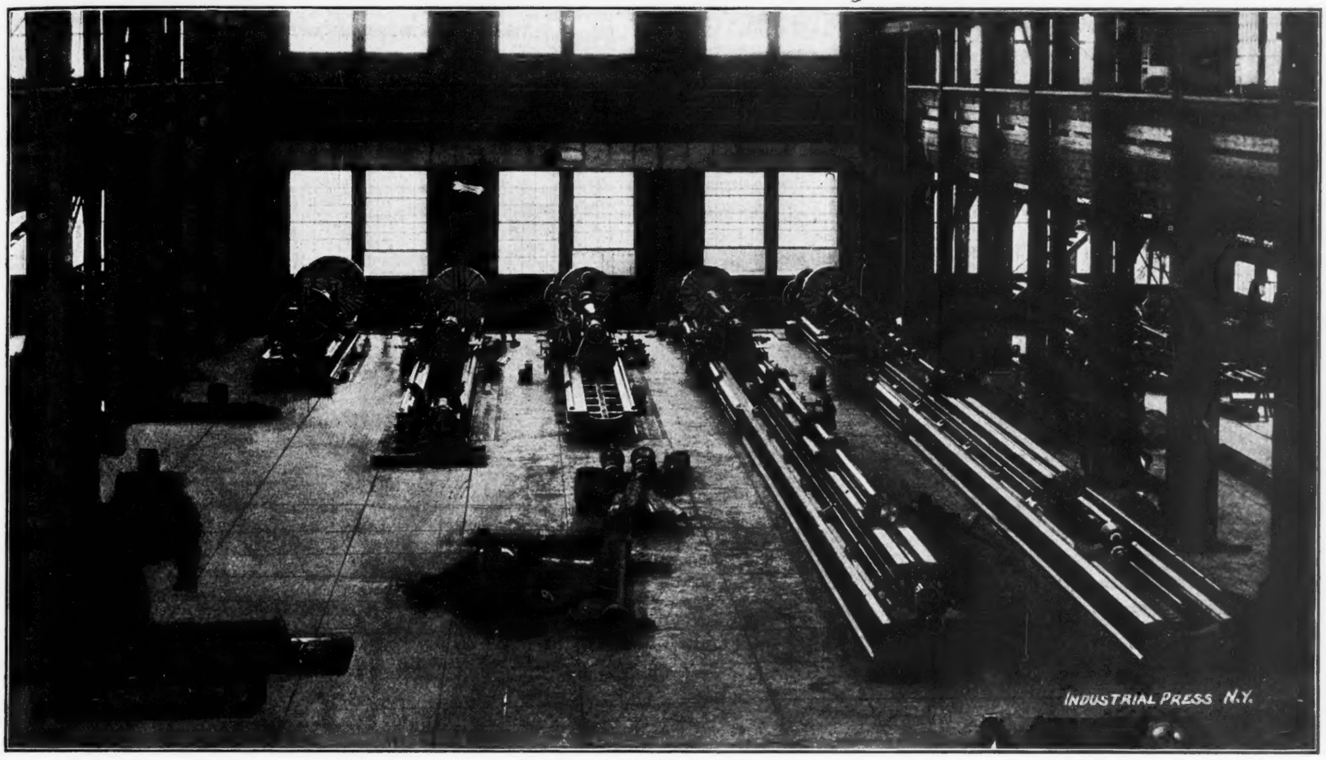


Fig. 2. Group of Fitchburg Lathes for Turning and Boring Heavy Forgings in the New Shops of the Fore River Engine Co., Quincy Point, Mass.

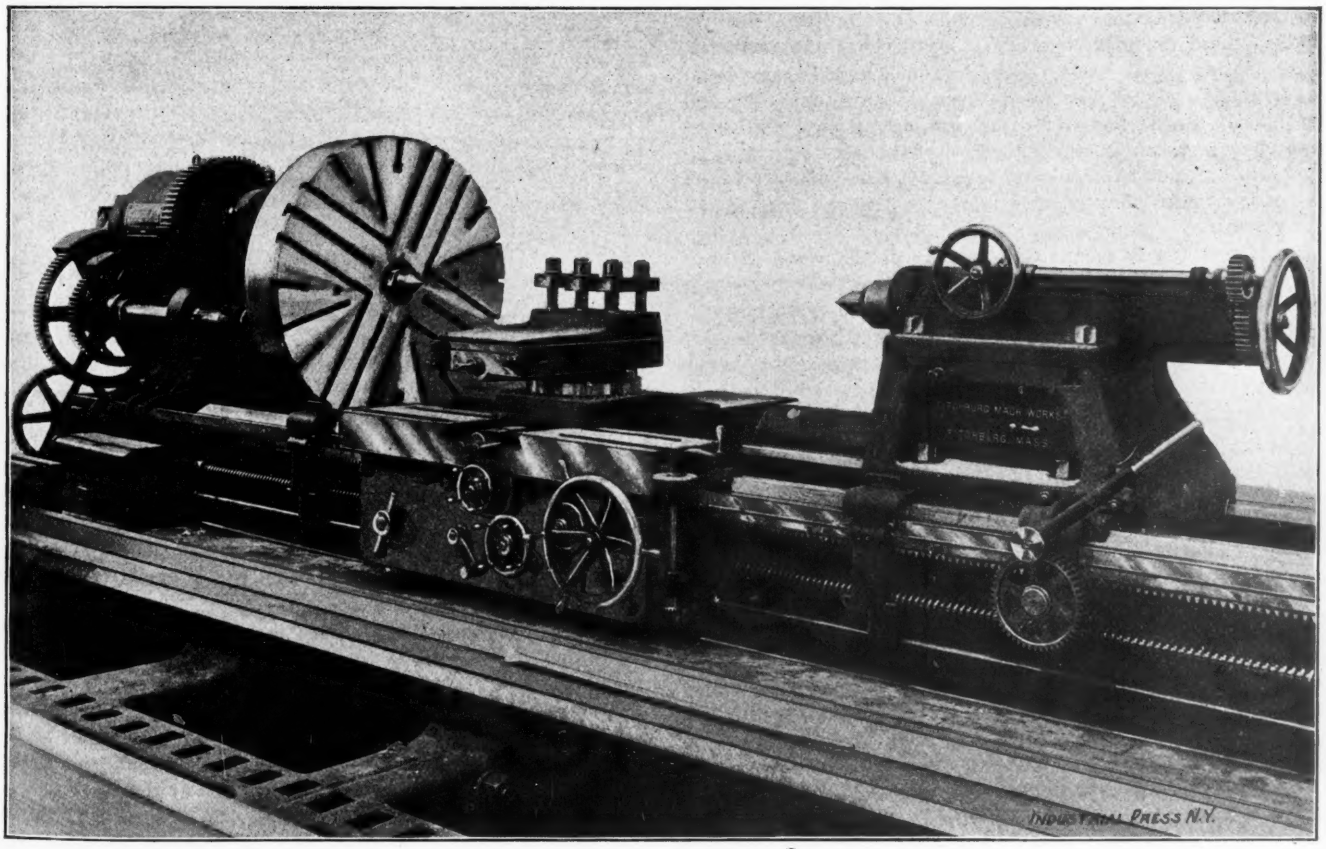


Fig. 3. General View of one of the Sixty-inch Fitchburg Lathes.

The motors, controllers and multiple-voltage system of the Bullock Electric Manufacturing Co. have been used; the motor is attached direct to the cone shaft, and was made special to give the regular cone speeds. The controller is operated by a crank on the side of the carriage, giving the

These lathes are adapted for any work where both power and accuracy are required, and they are furnished with belt drive as well as variable or constant speed motor drive. They swing 63 inches over ways, and can be made any length of bed desired.

THE FIREPROOFING OF WOOD.

METHODS OF FIREPROOFING AND RESULTS OF TESTS ON WOOD THAT HAS BEEN TREATED.

A. H. Eldredge.

In 1898, while instructor at Cornell University, the writer became interested in the fireproofing of wood, and under the advice of Prof. Roth, of the Department of Forestry, a series of experiments was begun to find what could be done toward fireproofing wood on a practical and economical basis. Mr. G. B. Preston, present State Boiler Inspector of New York State, was also an instructor at Cornell University, and assisted in the work. Soon after the work was begun, both Mr. Preston and the writer left the university to accept other positions before fully accomplishing the objects of the experiments.

The subject is one that offers a broad field for investigation, and promises to be of value to the general public in many ways. The time is coming when either the law will make it compulsory for the wood which enters into the construction of certain structures to be fireproofed, or the fire insurance rates will be such as to make fireproofing an object and thus practically to enforce it. Each year about $200,000,000 worth of insured property is destroyed by fire, many lives are lost, and much damage is done that cannot from a business standpoint be measured in dollars and cents; so that it is plain that whatever will reduce these losses will, sooner or later, become standard practice.

Wood that is used in dry places can be effectively fireproofed; as, for example, the wood that goes into the construction of a railroad train, or a sleeping car, or into a hotel, theater, office building, dwelling house, etc. In the case of a railroad train wreck it would frequently prevent the destruction of the train by fire, accompanied oftentimes by a needless loss of life.

There are two general classes of wood—i. e., hard and soft wood. The physical structure in either case is very complex. The soft wood is more homogeneous and its sap cells are smaller than in hard wood. It was frequently observed, while testing hard wood, that the smoke and gas would traverse the body of the wood three or four inches beyond the blaze. Such, however, was never the case with the tests on soft wood. This fact offers one explanation of why hard wood is more difficult to fireproof than soft wood, and why a treatment that is satisfactory in the one case is not in the other.

By fireproofing is meant the treating of the wood in such a manner that it will neither burn of itself nor propagate combustion. It does not mean that it is indestructible; it would still be possible, under high temperatures, to destroy wood that had been fireproofed, just as it is possible, under similar conditions, to warp, twist or melt the iron work of a supposedly fireproof construction.

Methods of Fireproofing Wood.

Wood can be fireproofed in a number of different ways; for example: By protecting it with some non-conductor, as asbestos; by painting with a fireproof paint, or by subjecting it to some chemical treatment. The second method has considerable merit and there are a number of fireproof paints on the market, the best of which no doubt contain more or less of some of the chemicals mentioned in this article. Whitewash is recognized as being of value as a fireproofing material, and special rates are allowed by the fire insurance companies for buildings that are whitewashed over those that are not.

The theory of the fireproof treatment is that wood so treated will evolve a gas that will not support combustion, and wood so treated will not, as a consequence, burn of itself. There are two ways in which wood burns; one is with a flame and the other with a glow. The kind of burning, whether by flame or glow, was always carefully noted in our tests.

The principal requirements of a good fireproofing material are as follows: First, it must be effective; second, it must be durable; third, it must be safe; fourth, it must be cheap. Where wood is used in dry places the first requirement is easy to meet. The second is difficult to meet where the wood is used in damp places, as the salt of the reagent will gradually seep out of the wood, thus destroying its fireproofing qualities—the action being similar to that of water on common salt. The third requirement can be easily determined by knowing the reagent used for fireproofing. The chloride of mercury (HgCl) if used will emit a poisonous gas under high temperatures, and therefore should not be used. The fourth requirement was not determined.

In selecting the reagents to be used in these tests, advantage was taken of the previous work of the chemist, and only such salts and chemicals were used as promised the best results, as follows:

Ammonium chloride .... NH_4Cl
Magnesium chloride .... $MgCl_2$
Calcium chloride .... $CaCl_2$
Zinc chloride .... $ZnCl_2$
Ammonium phosphate .... $(NH_4)_2HPO_4$
Alum .... $Al_2(SO_4)_3$

Method of Conducting the Tests.

The test pieces were ¼ inch square and 8 inches long. They were held by one end in a jig, at an angle of 45 deg., while the other or lower end was placed in the center of the flame of a Bunsen burner. The distance from the jig to the center of the burner was kept constant throughout the tests. The test pieces were first dried in a dry kiln, then boiled in the fireproofing solution and dried a second time, after which they were left for 24 hours in the open room so as to absorb the normal amount of moisture in the atmosphere before being burned. The first tests were conducted for strength of solution and time of treatment, from which standard strengths of 5 per cent or 10 per cent and a time of boiling of 30 minutes were adopted. By strength of solution of 5 per cent is meant that 5 per cent of the reagent and 95 per cent of water by weight were used. In no case was the test piece removed from the flame of the burner until it had ceased to burn. Untreated pieces of wood, both pine and oak, were frequently tried, and in every case they were burned up, even when removed from the flame of the burner and held in a horizontal position.

Table I. Ammonium Chloride Solution.

F., flame; F. O., in flame only. Pieces ¼″ × ¼″ × 8″.

Strength of Solution, per cent.	Time Boiled, mins.	Pine.			Oak.		
		Burned, inches.	Glowed, inches	Charred, inches.	Burned, inches.	Glowed, inches.	Charred, inches.
1.5	5	2.75	2.75	2.75	2.50	2.50	2.80
1.5	15	2.00	F. O.	2.00	2.75	F. O.	2.75
1.5	30	1.75	F. O.	1.75	F. O.	1.75	F. O.
3.5	5	4.50	4.00	4.50	1.50	F. O.	1.50
3.5	15	2.00	F. O.	2.30	2.00	1.50	2.00
3.5	30	1.50	F. O.	1.75	1.50	F. O.	1.50
5.0	5	F. O.	F. O.	2.25	5.00	F. O.	5.25
5.0	15	F. O.	F. O.	1.75	1.50	F. O.	1.50
5.0	30	F. O.	F. O.	1.75	2.25	F. O.	2.25
Zinc Chloride Solution.							
1.5	5	F. O.	F. O.	1.60	F. O.	F. O.	1.90
1.5	15	F. O.	F. O.	1.75	Burned up freely.		
1.5	30	F. O.	F. O.	1.60	1.75	1.75	1.80
3.5	5	F. O.	F. O.	2.25	4.75	4.75	5.00
3.5	15	F. O.	F. O.	2.25	F. O.	F. O.	2.25
3.5	30	F. O.	F. O.	1.50	Burned up freely.		
5.0	5	F. O.	F. O.	2.25	F. O.	F. O.	2.00
5.0	15	F. O.	F. O.	1.50	Burned up freely.		
5.0	30	F. O.	F. O.	1.50	F. O.	F. O.	1.75

The accompanying tables illustrate the action of both hard and soft wood under the various treatments. Table I. shows the effect of weak solutions and short periods of boiling; table II. shows more uniform results with stronger solutions and a longer period of treatment; table III gives the results of an ammonium hydrate treatment that is especially adapted to moist places; table IV. is the summary of the work.

In the ammonium hydrate treatment the wood is first boiled in a solution of zinc or ammonium chloride, then kiln-dried, and next boiled in a solution of alum water. In order to save the solution of alum water the wood should be removed from the solution of alum water and placed in a boiling solution of bicarbonate of soda. This second treatment to alum and bicarbonate of soda causes a deposit of ammonium hydrate all through the pores of the wood. Ammonium hydrate is very hard; it will not dissolve in boiling water nor

Table II. Ammonium Chloride Solution.
F., flame; F. O., flame only. Pieces ¼" × ¼" × 8".

Strength of Solution, per cent.	No.	Pine.			Oak.		
		Burned, inches.	Glowed, inches.	Charred, inches.	Burned, inches.	Glowed, inches.	Charred, inches.
5	1	2.00	2 00	2.75	3.00	2.50	5.00
5	2	F. O.	F. O.	2.75	3.50	2.75	5.00
5	3	F. O.	F. O.	1.75	Bur	ned up fr	eely.
5	4	F. O.	F. O.	1.75	3 00	3.00	5.00
10	1	2.50	2.25	3.00	F. O.	F. O.	2.00
10	2	F. O.	F. O.	2.25	F. O.	F. O.	2.25
10	3	2.50	2 50	3.00	F. O.	F. O.	2.50
10	4	....	....	....	F. O.	F. O.	1.50
Zinc Chloride Solution.							
5	1	F. O.	F. O.	2.50	F. O.	3.50	3.50
5	2	F. O.	.F. O.	2.25	F. O.	F. O.	2 00
5	3	F. O.	F. O.	2.25	*7.50	6.50	7.50
5	4	F. O.	F. O	1.50	6.00	5.00	6 50
10	1	F. O	F. O	2.00	F. O.	F. O.	2.50
10	2	F. O.	F. O.	2 00	3.00	2.50	3.50
10	3	F. O.	F. O.	2.25	5.00	4.00	5.75
10	4	F. O	F. O.	2.00	4.50	2.00	5.50

* A very open piece of wood; burned slowly, finally going out.

burn in the flame of a Bunsen burner. This treatment, to a great extent, makes the wood water-, insect- and fire-proof. It imparts to the wood a bluish color that would probably spoil it for finished surfaces. None of the other treatments affected the color of the wood below the surface.

Table III. Zinc Chloride and Ammonium Hydrate Solutions.
F. O., flame only. Pieces ¼" × ¼" × 8".

Per cent Zinc Chloride	No.	Pine.			Oak.		
		Burned, inches.	Glowed, inches.	Charred, inches.	Burned, inches.	Glowed, inches.	Charred, inches.
5	1	1.75	1.75	2.50	4.50	4.00	4.75
5	2	2.50	2.00	3.00	4.00	4.00	4.75
10	1	F. O.	F. O.	2.25	F. O.	F. O.	2.50
10	2	F. O.	F. O.	2.50	F. O.	F. O.	2.50

In addition to the tests with ¼-inch test pieces, some work was done with pieces that were 1 inch x 4 inches x 18 inches and 2 inches x 4 inches x 18 inches of white pine, yellow pine, oak and hemlock. These pieces were boiled for 30 minutes in a 10 per cent solution of ammonium chloride, then kiln-dried and afterwards burned in the flame of a Bunsen burner. The greatest distance charred on any of the larger pieces tested was 7 inches for white pine, 8½ for yellow pine, 4 inches for hemlock and 7 inches for oak.

Table IV. Summary of Distances in inches Burned on any Piece Tested.
Maximum length, 8 inches. Pieces ¼" × ¼" × 8".

Name of Reagent.	Strength of Solution, per cent.	Pine.		Oak.	
		Greatest.	Least.	Greatest.	Least.
Ammonium Chloride	1.5	2.75	1.75	2.85	1.75
	3.5	4.50	1.50	2.00	1 50
	5.0	2.75	1.75	8.00	1.50
	10.0	3.00	2.25	2.50	1.50
Zinc Chloride	1.5	1.75	1.60	8.00	1.90
	3 5	2.25	1.50	8.00	2.25
	5.0	2.25	1.50	8.00	1.75
	10.0	2.25	2.00	5 75	2.50
Magnesium Chloride.	1.5	3.00	2.25	8.00	2.25
	3.5	3.00	2.25	3.25	2.25
	5.0	2.75	1.50	3.25	2.00
Calcium Chloride.	1.5	8.00	1.25	8.00	4.50
	3.5	2.75	2.00	8.00	2.00
	5.0	1.75	1.50	8 00	2.00
Ammonium Phosphate.	1.5	2.25	2.25	5.50	2.20
	3.5	2.25	1.50	8.00	1.75
	5.0	2.30	1.50	1.75	1.75
Alum	5.0	5.00	4.50	8.00	8.00
	10.0	3.00	2.75	8.00	8.00
Zinc Chloride and Alum	5.0	3.00.	2.50	4.50	4.00
	10.0	2.50	2.25	2.50	2.25

The results of the experiments would seem to prove the following:

First. That soft wood is more easily fire proofed than hard wood.

Second. That the strength of solution should not be less than 5 per cent for soft wood, nor less than 10 per cent for hard wood.

Third. That wood properly fireproofed will neither propagate nor support combustion.

TOOLS FOR INTERCHANGEABLE MANUFACTURING.—4.

DRILL JIGS FOR HEAVY MACHINE PARTS.

Joseph Vincent Woodworth.

The introduction of tools and fixtures for the production of duplicate parts of heavy machinery and tools has necessitated the devising of means and the designing of fixtures by the use of which the part, or parts, to be machined could be handled with ease and expedition. The result has been that where the proper design and construction in the fixtures has been carried out, the finished work has proved vastly superior to that done by the old methods.

In designing and constructing drill jigs for heavy parts there are a number of obstacles to be met and overcome, not found in jigs for the different classes of work shown in the preceding articles. They are in effect as follows: In the increased size and strength of the jig castings. Then in the locating and fastening points for the work, which must be so situated as to allow the work to be located and fastened within the jig with the least time and exertion on the part of the operator. Lastly in the locating and finishing of the drill bushing holes, which cannot (as a rule) be successfully accomplished by the same means used in the construction of jigs for small parts.

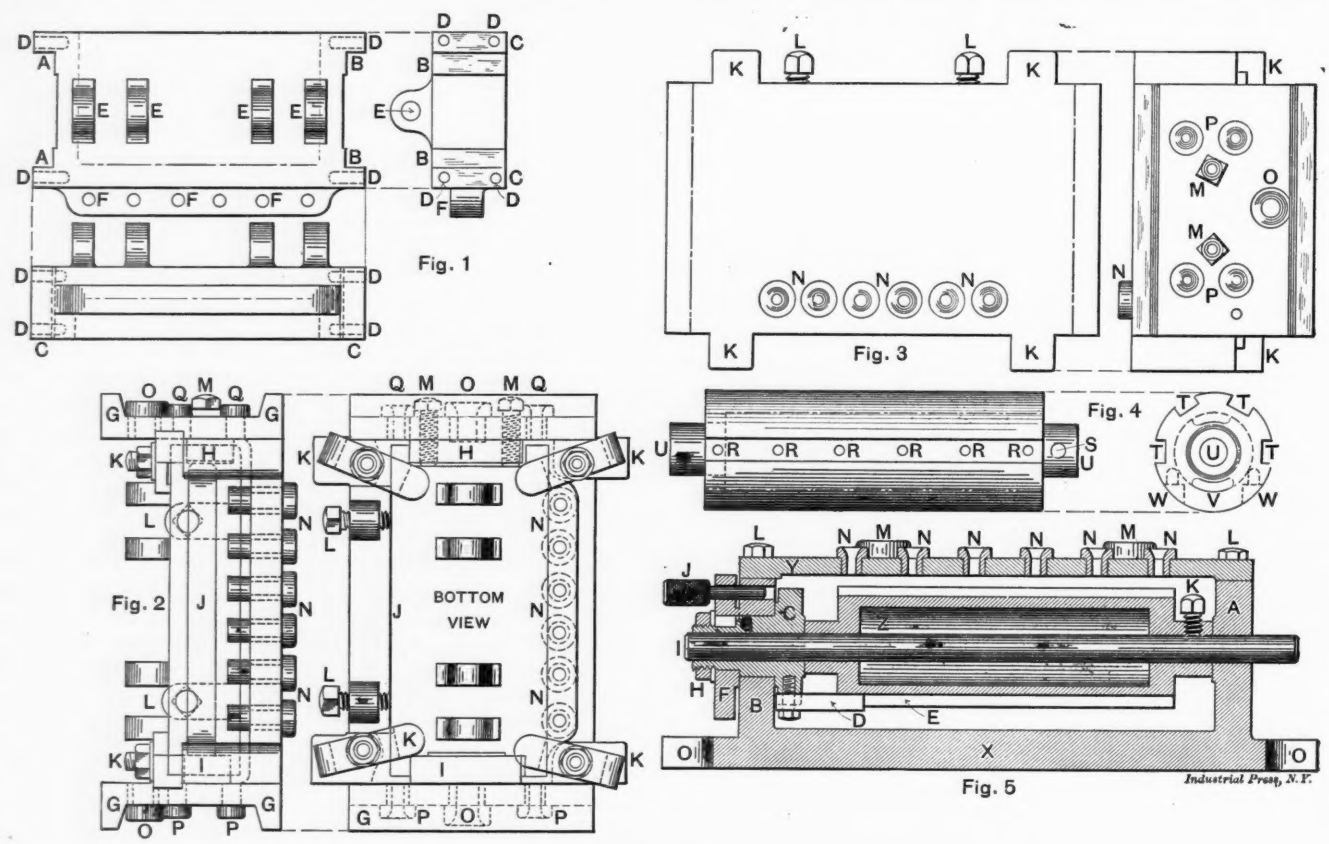
As the main castings of jigs for heavy parts are of considerable size and weight, it is not always possible to swing them on the lathe faceplate and finish the bushing holes, as the cumbersome shape and size of the casting make the accurate locating of the buttons a difficult task indeed. The only other method that will answer the requirements as to accuracy in the spacing and finishing of the holes is by strapping the jig castings on the table of a large B. & S. or "Cin." universal milling machine, equipped with a vertical attachment, and locating the holes by the use of the cross and longitudinal graduations, the vertical feed, a pair of 12-inch verniers, and a B. & S. height gage. First locate and drill the holes in the top of the jig with a small drill chuck that fits the socket of the vertical attachment and a short, stiff centering drill. Spacing, centering, and drilling the holes in their approximately proper position, by using the different graduations, and then going over them and finishing them to size, and in their accurate location to each other. For this use a spindle turned to fit the socket of the attachment, and insert a cutter through it, thereby having a small boring bar. Then, finding the distance from the outside of the boring bar, to the working side of the jig, deduct one-half of the diameter of the bar, and move the cross, or longitudinal feed, the number of thousands required. After the first hole is finished and a nicely fitting plug is inserted within it, finish the remaining holes on that side by working from the plug and the side of the jig with the verniers, and from the base with the height gage. The holes in the other sides of the jig can then be finished in the same manner by reversing the jig or removing the vertical attachment and working directly from the miller spindle, whichever may be found necessary. By the use of the above means all holes can be finished, and when tested will be found (after the hardened and ground bushings have been inserted) to be correct to the thousandth.

The numerous and various jigs illustrated in the accompanying illustrations show clearly the most practical design and construction for the various shaped castings shown. In Fig. 1 are three views of a cast-iron crosshead for a nailing machine. This is finished at three points, at *A A*, *B B*, and the bottom *C C*. The holes drilled are eighteen in number, four at each end at *D*, four at *E*, and six at *F*, in the front projection. The jig for drilling them is shown clearly with the work fastened within it in the two views of Fig. 2, and in a top and end view in Fig. 3. It consists of one casting with legs at each end at *G G*. The work is located by forcing it endways down on the locating piece *I* by the two setscrews *M M*, and sideways against the two locators *I* and *H* respectively, by the setscrews *L L*, see bottom view, Fig. 2. Four straps, *K K K K*, fasten and hold down the work securely on two raised and finished spots in the bottom of the jig. The bushing holes are located and finished by the method described in the begin-

ning of this series. When in use the work is fastened within the jig by slipping it down on the locating points and tightening all screws and clamps. The jig is then stood on end on the legs, *G G*, and the holes are drilled through the bushings, *Q Q*, after which it is reversed and the holes in the opposite end drilled through the bushings, *P P*. The large hole through the four projections is then finished by inserting a boring bar through the bushings, *O*, and the cored holes in the four projecting lugs of the crosshead, in which four cutters are fastened, one end of the cutter bar being fastened in the drill-press spindle and the other end running into and passing through the hole in the center of the table, as the bar is fed down. The bar is now removed, the jig turned on its back and the six holes, *F*, Fig. 1, drilled through the bushings, N. The design of this jig is as simple as possible, and allows the work to be drilled to be very rapidly located, fastened, drilled and removed. The projecting lugs on the sides for the straps or clamps, *K K K K*, strengthen the ends of the jig, and overcome the tendency to weakness in the projecting ends. The use of a boring bar with four cutters for finishing the holes, *E*, Fig. 1, is both economical and productive of good results, saving time in the finishing of the holes and insuring their alignment with each other when finished. The use of the clamps for fastening the work tends to the rapid fastening and releasing of the work, as by a single turn of the nuts they can be swung on or off.

In the two views of the cast-iron impression roller, Fig. 4, we have a piece of work that would be difficult to handle without the use of a jig. The roller is turned and finished in the lathe and then transferred to the miller and indexed for six, and the four channels, *T T T T*, are milled down its entire length. In each of these channels six holes, *R*, are drilled, and in the plain side of the roller four counterbored holes, *W W*, are let in. The inside of the roller is cored out as shown by the dotted lines, and the core vents at *V V*. A 2-inch hole through the ends at *U U* acts as a journal bearing for a revolving shaft. The jig is clearly shown in the cross-sectional view in Fig. 5, and in the top and end views of Fig. 6. *X* is the main casting, *Y* the bushing plate, and *I* the shaft on which the roller *Z* to be drilled is fastened. The locating plate *C* revolves in the end *B* of the jig and projects through to the opposite side, the index plate *F*, being keyed to it at *G*, and fastened by the nut *H*. The bushings *N* are for the six holes, *R*, in the channels, and those at *M* for the counterbored holes *W W*, Fig. 4. To locate the roller within the jig so that the channels in which the holes are drilled will be in line with the bushings, the locator *D* is used. It is fastened within a channel in *C*, by the capscrew shown, the piece *D* fitting the channel *E* snugly, as shown in the cross section, and the roller is fastened to the shaft *I* by the setscrew *K*.

In the end view of the jig, Fig. 6, the indexing holes in the plate *F* are shown—those for the holes in the channels are at *R R R*, and the one in which the index pin, *J*, is entered, four in all. That for the counterbored holes is at *Q*. The top view of the jig shows the position in which the bushings *N* and *M* are located and the manner of locating the bushing plate by the four screws *L*, and the two dowel pins *P P*. By reverting to Fig. 5 the manipulation of the jig when in use and the drilling work will be understood. The shaft *I* is removed and the roller *Z* inserted, fitting between the locating plate *C* and the finished hub on the end *A*, with the locator *D* in the first of the channels. The shaft *I* is then slipped through and setscrew *K*, in the roller, tightened. The jig is then set on the table of a large adjustable multiple-spindle drill, six of the spindles being set so that the drills will enter the six bushings *N*, and four of the remaining spindles set so that the counterbores will enter the bushings *M*. The jig is then fastened securely to the press table, by capscrews through the ends at *O*. The four holes *W* (Fig. 4) are then counterbored, first removing the drills from the other six spindles. The counterbores are then removed, the six drills refastened in the spindles, and the index plate revolved until the first channel in the work is under the bushings *N*. Index pin *J* is now entered, and the six holes drilled, when the index plate is moved for the next channel and the holes drilled in it, the holes in the remaining two channels being drilled in the same manner. The use of this jig together with the multiple spindle drill makes the handling and drilling of a heavy roller a simple operation, that would, however, be difficult to perform satisfactorily by any other means. Moreover, the work produced will be found to interchange perfectly.



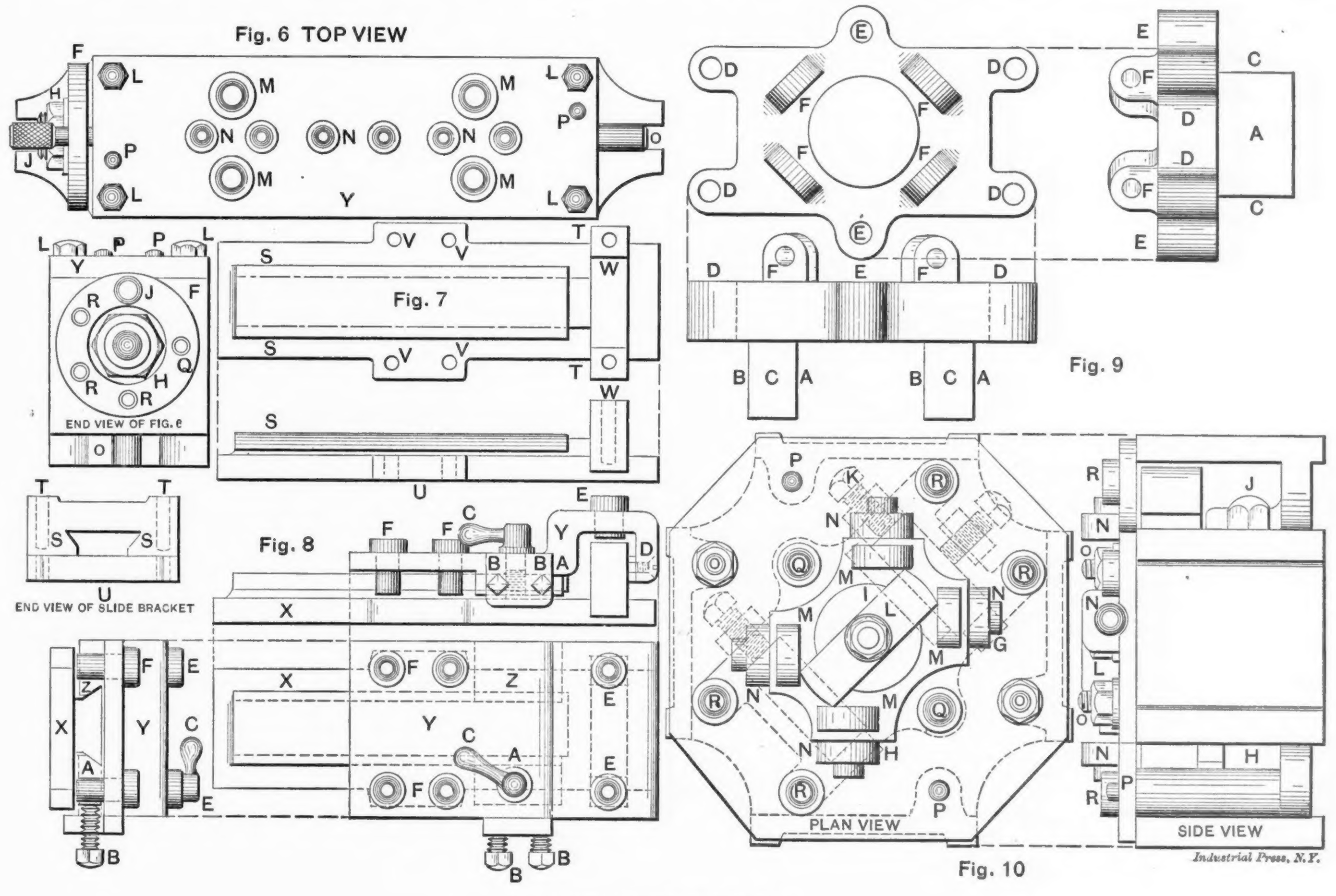
Group of Drill Jigs.

A separate and distinct type of jig for heavy work is shown in the three views of Fig. 8. It is used for drilling all the holes in the dove-tailed slide bracket shown in Fig. 9, and, as will at once be seen, it can be located on the work, simply and rapidly. The bracket (Fig. 7) has four holes drilled at *V V*

V V, and two at *W W*. The four holes *V* are for fastening the bracket to the body of the machine of which it forms a part, and those at *W W* for fastening a spindle bearing to this portion of the bracket. The casting, before being drilled, is machined on the back at *U*, planed dove-tail at *S S*, and a cut is taken off the top at *T T*. The dove-tailed surface is utilized as the positive locating point for the jig, as it is shown secured on the work in the three views of Fig. 8. The bottom of the jig and the point *Z* are finished to coincide with the dove-tailed surface of the work. The angular-faced clamp *A* is forced up against the work by the two setscrews *B B* and drawn up tight by the clamping lever and stud *C*. The end-locating point is at *D*, which consists of a flat steel plate fastened to the overhanging end of the jig by two flat-head screws. The four bushings *F F* project down almost to the face of the jig, this being necessary, as the casting at this point was not machined. When being drilled, the casting rests on the back *X*, and the jig is located and fastened on it as shown in Fig. 8. The holes drilled, the jig is quickly removed by loosening the two setscrews *B B*, and the clamping lever *C*, which allows the clamp *A* to be slid back, and the jig removed. The design of this jig gives a practical illustration of how simple and inexpensive tools for the drilling of heavy parts can be constructed, by choosing the most adaptable locating points on the work, and designing the jig castings so as to have as few points as possible to machine. When locating and finishing the bushing holes in this jig, it was first finished at all points necessary, and then clamped to the slide bracket, or work, which was in turn clamped to the miller table, with the top of the jig up. The holes were then located and finished by getting the distances from the machined surfaces of the work and using the vertical attachment, thus doing away with the necessity of first laying out the holes on the work, then finding their location in the jig. This is a very good plan to follow, when the shape of the jig castings will not allow of their easy fastening to the miller table. Moreover, in getting the distances between the bushing holes, the machined surfaces of the work are reliable points to measure from.

Fig. 10 shows still another jig, in two views. It is for drilling all the holes in the press bolster shown in Fig. 9. The casting, as can be seen, is a rather difficult one to handle, but by the use of this jig the drilling is accomplished with ease and expedition. The only finishing done on the casting, before drilling, is to plane all sides of the two oblong projections, as shown at *A A*, *B B*, and *C C*, to gage. The holes drilled are the four *D D D D*, the two *E E*, and one through each of the projections *F F F F*.

The jig (Fig. 10) is in two parts, the lid and body casting. There are legs on four sides and on the bottom. The casting to be drilled is located from the two oblong projections on the back, as shown in the plan view, by the locating spots *G*, *I*, and *H*, and the setscrews *K K* and *J*, the large strap *L* holding it securely in the bottom of the jig. The lid is located by the two nuts *O O*. The bushings *N*, through each of the projecting lugs on the face of the lid, are for the holes through *F F F F*, in the work. The four bushings *R* are for the holes *D* and those at *Q Q* for the holes *E E*. When the jig is in use the work is located and fastened within it, as shown by the dotted lines in the plan view of Fig. 10. It is then rested on its back and all the holes in the face are drilled. The holes in the projecting lugs of the casting at *F* are drilled by standing the jig on each of its sides in turn and drilling down through the bushings *N*. In this jig the amount of time taken to locate, fasten and then drill the work amounts to very little, when the shape and bulk of the casting is considered. Jigs of this design can be used to the best advantage for the drillings of heavy castings on which are a number of projecting lugs, and when holes are to be drilled in them to a given line, or in line with each other, as in the case of the casting drilled in this one.



Another Group of Drill Jigs.

* * *

At the West Oakland shops of the Southern Pacific Railway a method is in use for welding cracked locomotive frames in place. A small furnace of fire brick is built around the frame at the crack and an oil burner is then introduced and operated till the frame is brought to a welding heat. At the June meeting of the Pacific Coast Railway Club, Mr. Kellogg, the foreman of these shops, stated that an engine was recently brought in off the road at 8:30 A. M. with the main frame broken under the rocker box. In 22 hours the engine was back on the road hauling its train.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1901.

CIRCULATION STATEMENT.

MACHINERY reaches all classes—journeymen, foremen, draftsmen, superintendents and employers; and has the largest paid circulation in its field in the world. Advertisers will be afforded every facility to verify the statement of circulation given below.

1900.		1901.		1901.		1901.	
Oct.....	24,000	Jan.....	27,500	April....	26,000	July.....	28,964
Nov.....	25,000	Feb.....	26,500	May.....	26,500	Aug.....	29,492
Dec.....	27,500	Mar.....	30,000	June....	28,000	Sept.....	28,165

No other paper in this field prints its circulation figures.

Tempering, annealing and case-hardening are three subjects upon which there has been very little practical information published. We solicit communications from any readers who have had experience in this class of work.

* * *

SKILLED MECHANICS VS. CHEAP LABOR.

In an editorial aftermath upon the machinists' strike, the *Iron Age* recently expressed sentiments concerning shop management and the employment of labor that we cannot consider other than representing a short-sighted shop policy.

Attention is first called to the well-known facts that many lines of manufacture have become so specialized that the skilled mechanic is often virtually "out of it," his place being taken by the machine hand or operator; and that all men working at tools in the machine shop are not skilled mechanics and cannot receive mechanics' wages. Then at one stroke the writer wipes the skilled mechanic out of existence by adding that "even in general shops the tools now in use are capable of being easily mastered by men of fair intelligence with some little education."

By way of illustration the following instance is related:

"In a certain shop a large planer was installed. It was a much bigger tool than any other in the shop, and represented quite a change in the equipment. A competent machinist was given charge of the planer, and after running it for a month he asked for an advance in wages, claiming that he should receive higher pay on account of its greater size and the heavier work turned out by it. He was given another job and a second man was assigned to the machine. In a short time he made the same demand, and a third man was put in charge of the planer, with whom the manager had a like experience. Growing tired of this result of putting good mechanics in charge of what he considered a very simple tool, the manager went to a laboring gang and asked the foreman to point out some man from among them of fair intelligence and a little education. Such a man was at once designated, and the manager conducted a civil service examination, as follows: "Can you read and write?" "Yes." "Have you ever worked in a machine shop or at any kind of a machine?" "No." This being deemed satisfactory, the man was taken into the machine shop and put in charge of the planer, and after a course of instruction extending over two or three weeks he was able to manage the tool without supervision, and was regularly employed to operate it from that time. The selection of this man was designed as a lesson to the men in the shop, who were persistently demanding higher wages whenever they could frame a pretext, usually a claim for superior knowledge or expert skill."

We do not know what shop this is, or anything about the circumstances of the case. The laborer may or may not have made a good planer hand, and the conditions may or may not have warranted the step that was taken. These features are of no particular moment, since it is the principle involved rather than the particular incident that we wish to comment upon. The policy is above outlined of employing men upon general work who have been "broken in" so as to mechanically perform this or that operation, but who have had no particular mechanical training such as a skilled mechanic of sound judgment must have. This policy we take exception to.

We are well aware that men of genius may be found in the ranks of laborers as well as among those in better circumstances, and we are glad when they have the opportunity to show their ability. No laborer, however, can become a competent planer hand without the experience and training commensurate with the work that a planer hand has to do. He may get this experience while he still goes by the name of "laborer," or he may get it afterward, but he must somehow obtain it. We predict that in the above-named shop the actual planer hand was not the laborer at all, but was his four-dollar-a-day foreman who might better have devoted his time to saving the company dollars per hour than in assisting the laborer in saving the company cents per day.

Suppose, Mr. Manager, that the treasurer of your company were a practical man, and that he decided your $2,500 services were no longer needed. Suppose he thought that your young assistant could run the shop at $1,000 a year, by keeping one eye on affairs himself. This would be carrying your policy to an extreme, it is true, but it is a poor rule which does not work up and down the line. Suppose, moreover, that you adopted the plan of employing men, who were not skilled mechanics, on all the machines in the shop. Where would you find a man for responsible work when you had such work to be done, and where would you obtain a foreman when you needed one?

We believe the best results are obtained where the average intelligence and ability of the workmen are high and the number of foremen employed few, rather than where the averages of intelligence and ability are low and the number of unproductive foremen employed to oversee the work is large. Where the former conditions exist good wages must be the rule, and we believe they represent money well invested. While requests for more pay are not always pleasant, we see no reason to deprecate them, since progress is impossible without ambition, and ambition is impossible without hope of something better ahead. In many shops the practice is adopted of giving an occasional increase without the asking, where a man has proven himself worth the money, which is a still more desirable method.

In spite of the introduction of automatic machinery, we believe there never was as good a chance for skilled mechanics as to-day, not only in the general machine shop, but in repairing and overseeing the automatic machinery which cheaper labor can operate. To become a skilled mechanic of to-day, moreover, one has much more to learn than was required fifty years ago, because there is so much more accumulated knowledge that he needs to have at his disposal. In spite of the introduction of automatic machinery, also, there were never so many machines of standard type in use in the general machine shop, and there never was a time when they required as careful and capable operators as at present, our contemporary to the contrary, notwithstanding. The tendency of the times is to increase the efficiency of each individual machine. It is made to operate on harder metals, to take heavier cuts, and the parts to move more quickly. Planers are constructed with four heads, instead of two, and they are expected to operate on a row of castings as long as the length of the bed instead of on single pieces. Lathes have improved systems of gearing, and often two toolposts instead of one. It is not necessary to mention the various improvements of recent years, but to get the most out of standard tools as they are built to-day requires more good judgment and actual skill than was necessary a few decades ago, when machine tools were comparatively simple mechanisms and scraped the metal off, so to speak, instead of slicing it.

NOTES AND COMMENT.

Brattleboro, Vt., has 7,000 population, and there is an automobile owned in the town for every 636 inhabitants. The people who live there are ordinarily well to do, few being counted as wealthy and few as poor. It is a typical New England village and if it represents average conditions for similar places, to say nothing of the cities where more wealth is concentrated, there is plenty of work ahead for automobile manufacturers.

An American mowing and reaping machine drawn by a pair of camels is hardly according to the fitness of things; but that camels are used for this purpose in countries where they are the common beast of burden is attested by the reproduction of a photograph of such an equipment in a recent magazine. In the meantime the Deering Harvester Co., Chicago, Ill., has built an automobile mower operated by a 4 horse power gasolene motor, and many other "auto" mowers and reapers are likely to follow. Customs differ.

The magnitude and importance of the pressed steel car industry is rapidly becoming evident. The Pressed Steel Car Co. have completed an order for seventy large capacity pressed steel hopper ore cars for the Great Southern Railroad of Spain. They were shipped from Pittsburg over the Baltimore & Ohio in a solid train of thirty-two cars. The new cars were packed in parts ready for shipment by steamer. An engineer from the Pressed Steel Car Co. will superintend the erection of the cars on their arrival in Spain. These cars are wider in gage than our cars, and every tenth car has a shelter box for a trainman built at one end and raised high enough to give an unobstructed view of the whole train.

THE LARGEST STEAMER.

The White Star steamer "Celtic," the largest vessel ever built, arrived at New York August 5 on her first trip. She was built at the works of Harland & Wolff, Belfast, Ireland, and was launched April 4, 1901. She is a slow boat, having engines of only 14,000 horse power, although her total displacement, full load, is about 38,000 tons, and registered tonnage is 20,880 tons. Her average speed on the first trip was 14.95 knots (17.2 miles per hour). She is a twin-screw ship, the screws being driven by quadruple-expansion engines. The diameters of the cylinders are 32, 47½, 68½ and 98 inches, all having a common stroke of 39 inches. The "Celtic" is designed for carrying freight, and passengers who care more for comfort than speed when making an ocean voyage, and because of her great size and comparatively slow speed the conditions for carrying freight cheaply and transporting passengers with little seasickness are extremely favorable. Her total length is 700 feet, breadth 75 feet, and depth 49 feet. There are nine decks, known as lower orlop, orlop, lower, middle, main, upper, bridge, upper bridge and sun decks. She has accommodations for 2,859 passengers, and carries a crew of 335 men.

BROOKLYN BRIDGE BREAK.

The discovery on July 24 that nine of the suspender rods on the Brooklyn Bridge had broken, and that the bridge floor had settled, caused a mild panic among the patrons of the bridge and much uneasiness of the officials in charge. It is well known that the bridge has long been subjected to a greater load than it was designed to sustain, and it was conjectured that this failure was a note of warning that the bridge is unsafe for the heavy traffic passing over it. Subsequent investigation, however, shows that with proper care and some alterations the bridge is good for many years to come. Owing to the large mass of metal in the cables supporting the structure there is a considerable difference in the amount of expansion and contraction of the cables and the metal trusses that support and stiffen the roadways. This inequality is compensated for by a slip joint at the center of the bridge, the trusses being fixed at each of the two towers, and each half sliding upon the other in the expansion joint at the center. The trusses are suspended by rods fastened to bands around the cables, and there are journals or trunnions at the bottom of the rods having a bearing in the trunnion blocks attached to the framework. The object of the trunnion blocks is to allow the suspender rods to swing one way or the other as much as necessary to compensate for the motion due to the expansion, or contraction, of the trusses. It seems that the trunnions have not had proper care and many of them have rusted in the blocks, preventing any rotary motion between the two, and making it necessary for the rods themselves to bend every time the lengths of the trusses changed through the action of heat or cold. The final outcome could not be other than the breakage of the shorter rods. They began to give away at the center of the bridge, where they are the shortest, and each one that broke threw additional stress upon the others, which hastened their deterioration. It should also be said that the construction of the blocks is such that it is difficult to give them proper lubrication, even when the bridge is thoroughly looked after, which it is claimed it was not. It is possible that an improved form of block will be substituted for those now in use, and it is to be hoped that the politics connected with the care and supervision of the bridge will not interfere with more competent supervision in the future than it has had in the past.

PROGRESS IN SHIPBUILDING.

The extent to which shipbuilding is now being carried in this country is unprecedented. Two new yards have recently been equipped, one of these being the Trigg Co.'s yard at Richmond, Va., and the other the Fore River Engine Co.'s plant at Quincy Point, Mass., which was described in a recent number. The former of these is now building the protected cruiser "Galveston," and the latter is building the protected cruiser "Des Moines," and has contracted for two of the largest battleships. The Eastern Shipbuilding Co., New London, Conn., are prepared to compete for the largest work, and have under construction two steel steamers for the Great Northern Steamship Co. and Northern Pacific Railroad. These will be the largest freight-carrying steamers in the world, having about the same dimensions as the "Celtic," the largest ship afloat. The immense new yard of the New York Shipbuilding Co., Camden, N. J., has contracts for four steamers for the Atlantic Transport Line, all of them very large vessels. The Boston Steamship Co., a new organization, also has two vessels under construction for foreign trade, and two are building at Sparrow's Point, Md.

All of the old yards are crowded with work. The American Shipbuilding Co. has under construction at its various yards on the lakes twenty-five vessels, while other lake builders have contracts aggregating $9,000,000. The yard at Newport News, Va., has under construction or contract a larger tonnage than any American yard has ever had up to this time, including six cruisers and battleships for the government, and an equal number of merchant steamers of unusual size. Two of these are Pacific Mail steamers, which have already been referred to in our account of the Newport News works published some time ago. The Union Works, of San Francisco, are building five vessels for the navy, and two large merchant steamers for the American-Hawaiian Steamship Co. Three battleships are being built by the Cramps, who have also in hand two 12,000-ton ships for the Red Star Line. Most of the coast shipyards also have orders for freight and passenger steamers for the coastwise trade.

The outlook for the future is quite as satisfactory as the record of the past. In addition to an increasing amount of merchant work there will be more vessels building for the government than at any previous time. Fourteen warships have been contracted for during the past year, and the construction of four more has been authorized. There is to be a new shipyard at Chester, Pa., the company for which has been organized with a capital stock of $3,000,000. It has also been rumored that capitalists are to establish one of the largest drydocks and shipyards in the world on the New Jersey flats, a short distance west of the immigration station on Ellis Island, in New York harbor. The drydocks, if built, will accommodate the largest ocean steamers, and any ship entering the port of New York will be able to enter them for repairs.

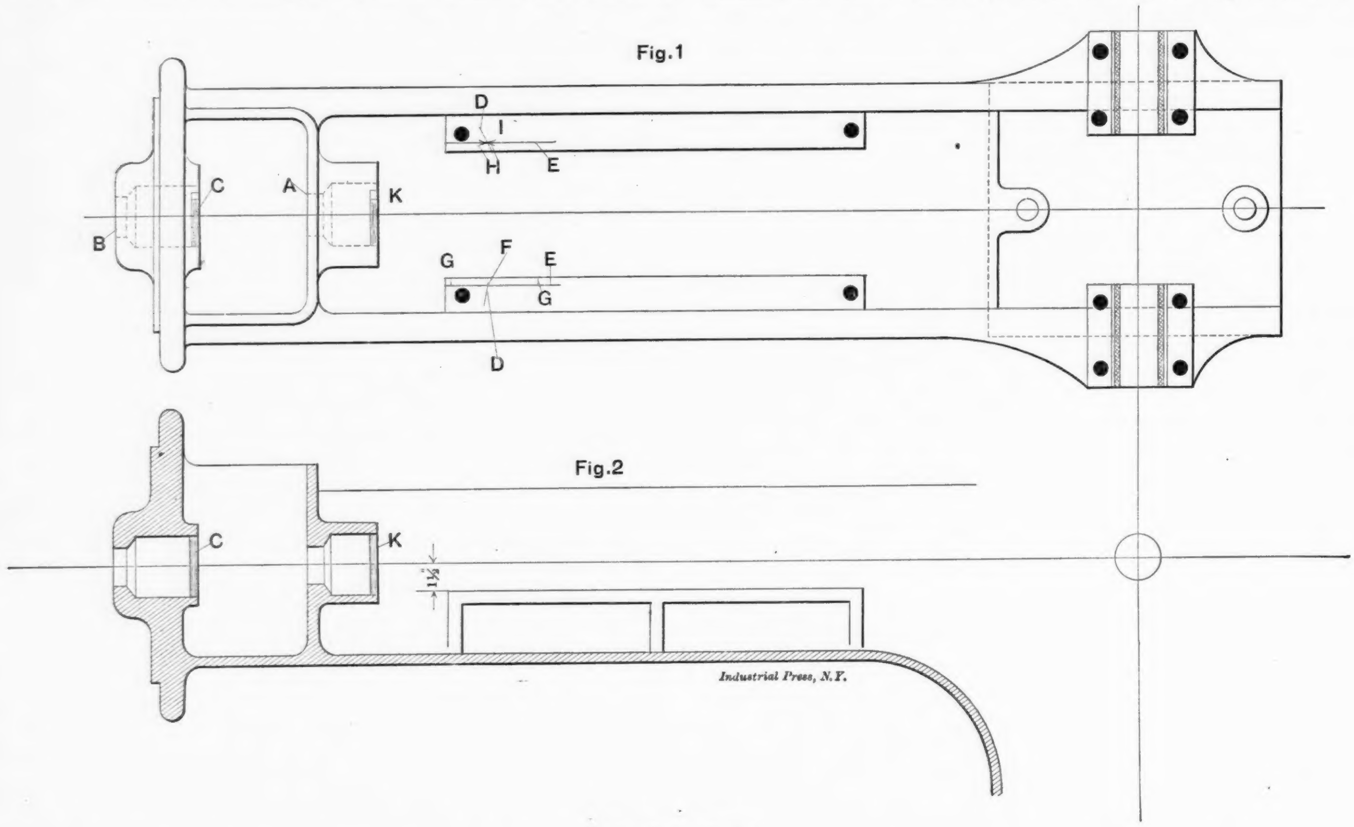
LETTERS UPON PRACTICAL SUBJECTS.

LOCATING TROUBLE ON A POWER PUMP FRAME.

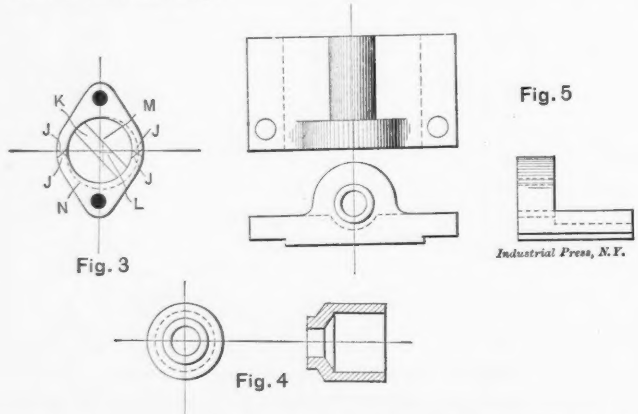
Editor MACHINERY:

Not long since I was directed by the general foreman of the shop to look up and report trouble on 18 x 12 power vacuum frame that was being erected.

After looking it over and inquiring of the man who was erecting the pump, I found the piston rod would bear hard at point *A* and *B* in the throats of the stuffing boxes, and it was impossible to move the cross-head the whole length of stroke. The pump was nearly completed and it would have been quite a job to tear down the whole thing and square up on the table and locate the stuffing boxes in relation to the counter-bore and cross-head race-way. It would be cheaper if I could locate the trouble without this work, so I went about it in this way:



Power Pump Frame.



First I wanted to know if the stuffing box next to the cylinder was in line with the cross-head. I placed a stick in this box at *C* and found the center, and from this center struck arcs *D D* on the cross-head race-way. Lines *E* were then drawn parallel with the edge of the race-way, cutting arcs *D D*. From *F* as a center I drew arcs *G G*, and from *G G* as centers struck arcs *H*. I found that these arcs crossed at point *I* on the straight parallel line on the race-way, at the intersection of arc *D*, which convinced me that the stuffing box *C* was central with the race-way, and hence with the cross-head.

The trouble must therefore be with the stuffing box *K*. Fig. 3 is a front view of the face of this box, showing the lines that were laid out to determine whether the center of the box was correctly located. Using *I* and *F* as centers, I struck arcs *J J J J*, Fig. 3. I then placed the stick in position in this box and drew line *L* across it from the points of intersection of lines *J J J J*. I then drew line *M*, which, according to the drawing, should intersect the center of the stuffing box at a point 1½ inches above the top surface of the race-way. The intersection of lines *L* and *M* gave the true center of the stuffing box, and it was found that the stuffing box had not been bored true with this center. From this center I laid out circle *N* large enough so that by boring to the line we would get a round hole. After reporting the matter it was decided to rebore the stuffing box. It was found that after this was done the stock left would not be strong enough to stand the pressure of the packing, so the hole was bored large enough to take a steel bushing, shown in Fig. 4. Fig. 5 shows a fixture I designed for clamping on the race-way for a guide in boring the box with a bar. This was done before with a long mill and nothing to guide the bar except the throat of the stuffing box, and the mill would thus be liable to crawl in almost any direction. C. W. PUTNAM.

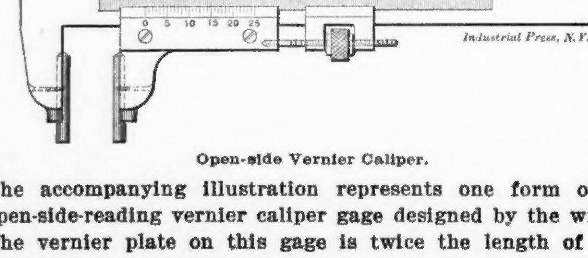
Holyoke, Mass.

* * *

A THREE-INCH OPEN-SIDE VERNIER CALIPER.

Editor MACHINERY:

A vernier caliper, when correctly made and well understood, has an important place in accurate mechanical work.



Open-side Vernier Caliper.

The accompanying illustration represents one form of an open-side-reading vernier caliper gage designed by the writer. The vernier plate on this gage is twice the length of that

on an ordinary gage reading to thousandths of an inch, which brings the reading on every second line, instead of every line, as when a caliper bar is cut to fortieths of an inch. It is easy to read and admits of the vernier plate being cut so as to allow readings of 1-2000 of an inch. The writer has a 6-inch tool-steel open-side vernier gage on which the vernier scale plate reads to 1-2000 inch, twice, that is, the vernier plate is double, and consequently the obtaining of a correct measurement by it is assured by two separate readings. It is in every way better than the ordinary commercial vernier caliper. In the gage shown in the illustration, the caliper bar is graduated in inches, subdivided into tenths and fortieths of an inch to a length of 3 inches. The vernier plate reads in thousandths of an inch for 25 thousandths, or through each scale division of 1-40 inch.

The caliper points are two tool-steel plugs, hardened and ground true, each to ⅛ inch in diameter by 1 inch long. A seat is made for each plug in each jaw of the gage by carefully drilling and reaming a hole between the jaws when they were brought together and mounted. The two screws, shown tapped into the plugs, serve to assist in holding the plugs in place when they are finally located in their exact position. The plugs should also be "sweat" in position, as, when thus located, they will not get out of place, unless, perchance, they get into the hands of some "mechanical ruffian," for whom a "monkey wrench" would be a far more appropriate measuring tool than any correct gage. Some mechanics may object to the circular form of the inside of the plugs in the jaws for measuring, but, if so, they may be ground flat on the inside. The object of using two separate plugs is that a higher grade of steel may be used than it is convenient to construct the caliper itself of. There is no real objection to the use of round inside faces when the high-grade steel is made use of, which may be hardened so that no wear can take place on them in years of use, and especially since, even in any case of breakage or wear, new ones are easily substituted. There are cases where the circular inside faces are useful, as the arrangement allows of accurate inside and outside duplication of sizes.

The plugs touch at a regular reading, and as the two plugs of ⅛ inch diameter make ¼ inch, it is only necessary to set the vernier ¼ inch under reading for inside measurements.

F. W. CLOUGH.

Orange, Mass.

* * *

PRACTICAL HINTS

Editor MACHINERY:

I had occasion to cut a small but very accurate keyway in a small shaft, using a shaper for the purpose. I laid out the keyway by first striking a center line *A B*, Fig. 1, across

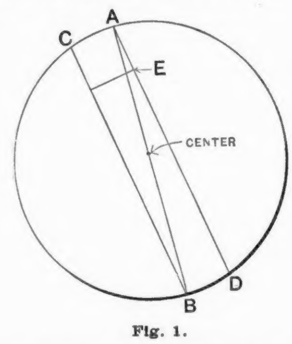


Fig. 1.

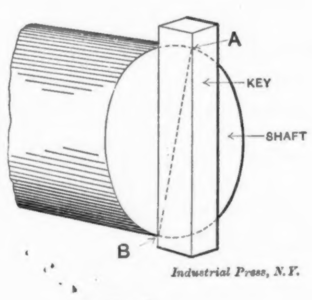


Fig. 2.

the end of the shaft, and to get the width of the keyway placed the key across the end of the shaft so that opposite sides would touch the ends of the line *A B*, as indicated in Fig. 2. Then with a scriber I marked the shaft on each

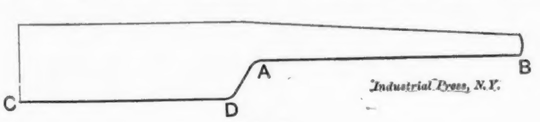


Fig. 3.

side of the key, as at *AD* and *CB* in Fig. 1, which gave me the sides of the spline exactly true with the diameter of the shaft, and without taking any measurements whatever. The shaft was then set true in the shaper by squaring with the tool to the line *AD*. The distance *A C* gave the width of, and *A E* the depth of the spline.

It frequently happens that one has a long and small hole to bore, and if a large and stiff tool is used it has to be blocked up and tilted to keep the under side of the back end from striking the bottom of the hole. To overcome this, have the tool forged as in Fig. 3, with side *A B* parallel with *C D*.

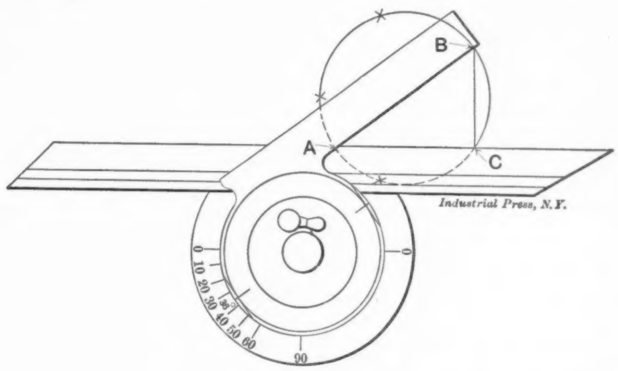


Fig. 4.

In a recent number of your paper I noticed a description of an adjustable centering square for finding the sides of a polygon. The same thing can be done with any bevel protractor as follows: Let $A = \frac{180}{N}$, where A = angle at which to set the protractor and N = number of sides of polygon.

When set, place one edge of the protractor on the center line *A B*, Fig. 4, with the points of the angle on the circumference, as at *A*, and mark where the other edge of the

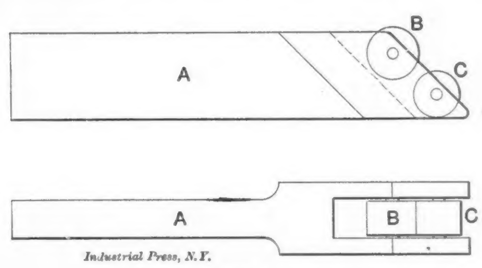


Fig. 5.

protractor cuts the circumference, as at *C*. Then *C B* will be the length of one side of the polygon. In this case it is a pentagon.

Fig. 5 shows a handy tool for trueing shafting when centering, without marring it. The body *A* is made of machinery steel and the two rollers *B* and *C* are tool steel, hardened and ground true. This tool, when held in the tool post and run up against a revolving shaft on the square center, will true it almost instantly.

SPLINE.

* * *

NOTES ON KEYS AND KEYWAYS.

Editor MACHINERY:

Under certain conditions keyways make a great deal of trouble for the key fitter, and the object of what follows is to mention some of the difficulties that are likely to be met and to explain methods of overcoming them.

One of the troubles is when the keyway is cut on an angle with the center line, as in Fig. 1. Such a keyway should be recut if very much out, as it is difficult to get a proper seat and bearings for the side of the key. Another trouble in long keyways comes from the variation in the stock of some shafts, and from hard and soft spots, making the keyway too narrow in places and too wide in others. This means that the keyfitter must straighten out the keyway before it is in proper condition to use. Still another trouble comes when the keyway in the bushing or piece that fits the shaft is not cut parallel with the center line, causing the key to bear at one end on one side and at the other end on the other side. Especially is this so when there is a double keyway with the center line of one keyway at an angle with the other and both off the true center line of

the bushing. Another trouble, also, comes when keyways are not cut exactly opposite each other in the shaft.

A handy tool for fitting keys is made like Fig. 2. One side is cut standard depth, while the other is 1-64 inch deeper than standard, the width being the same as the keystock. It is made of tool steel, tempered, a saw cut is made through the center and the end closed a little so as to hold the key. The portion not split should be worked out so that the key will go in free, which leaves the clamping to be performed by the split end, which is done in a vise. One side is cut 1-64 inch deep to allow for variations in the key. The keyways are supposed to be cut within limits of from exact size or standard to .001 inch small, so that the keystock, which is .002 to .005 large, will have a little stock for fitting.

By the aid of this holder work can be done on one-half the key to fit the shaft, and then by turning over the key the other half can be fitted to the piece going on the shaft. Forms can be made like Figs. 3, 4, 5 and 6, as well as others.

In Fig. 3 one keyway is larger than the other. Fig. 4 shows one keyway wider and off the center with the other; Fig. 5, half a key with round ends and half square; Fig. 6, one-half of key at an angle with other half.

When the keyway varies in width in a shaft, due to hard and soft spots, a cutter the size of the key, made by milling teeth in the sides (mill teeth so that the angle of cut on one side is opposite to that of the other, Fig. 7), can be forced along the keyway to make it of even width the entire length. To do this a bushing should be made to hold the cutter and a plate fastened to one end to form a stop to back it. Then for the keyway in the bushing or piece that is to go on the shaft, put this cutter in the keyway of the shaft, back it with a collar held in place by set-screws and force the piece over the cutter. This will make the keyway match in both pieces and correct the errors unless they are excessive. For double keyways true one keyway first and then the other by it, using a key in the first keyway to hold the bushing in position.

Great care should be taken in cutting keyways in change gears. If there are one or two a little large it is necessary to bring all the others up to them and make a special key. This can be done by broaching with a cutter like that just described. It should be made to the size of the keyway that is large and fastened in a short shaft with a central keyway. It can then be forced through all the gears, bringing them to a uniform size.

In cutting double keyways where one keyway must be directly opposite the other, a cutter-setting template can be used. For use on a shaft it may be constructed as in Fig. 8, which consists of a slotted ring, the slot just the width of the cutter and a set-screw with a slightly tapered teat to fit the keyway that is already cut. For the bushing or piece that goes on the shaft the same template can be used. Put the template on a shaft above the part that is to have the second keyway cut. The part to be cut is held in position by a key, then the second keyway can be laid off or the cutting tool located. Fixtures for indexing the parts in cutting double keyways will pay where there is enough of such work, as they will make the work nearer accurate and lessen the time required by the keyfitter.

With all the tools one can contrive it still remains for the workman to exercise judgment and skill, or he will be sure to remove more stock than necessary and have a loose fit or spend too much time on the work.

Providence, R. I. EDWIN C. THURSTON.

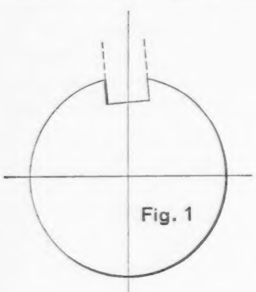


Fig. 1


Fig. 2


Fig. 3


Fig. 4


Fig. 5


Fig. 6

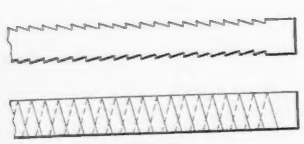


Fig. 7

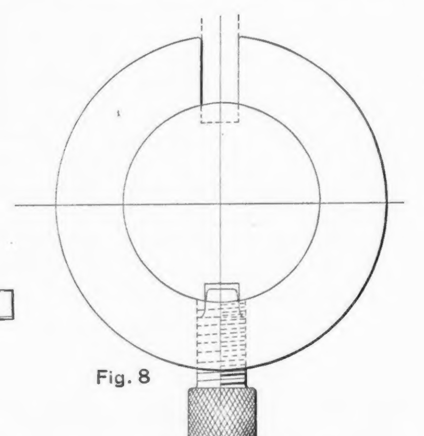


Fig. 8

Industrial Press, N.Y.

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JIG FOR MAKING THREAD CUTTERS FOR SECTIONAL PIPE TAP.

Editor MACHINERY:

The special jig used in making the thread cutters for the section pipe tap which was described in my letter to MACHINERY for June has proved of interest, and herewith are presented the diagram and description of the same.

In the diagram *E f* is a holder of machinery steel, with eight slots milled lengthwise and equally spaced upon it to receive the blank cutters, as shown at *B*. The blanks, which are 3 inches long, are held firmly in the slots by the nuts, *A* and *A'*, which are screwed up against both ends of the blanks. The nuts are made of tool steel and hardened, slightly conical on the inside and flattened on two sides for the wrench, as shown in the end views, *A* and *A'*. The blanks may be held very much more securely if their ends are planed or milled off about 5 degrees, as shown in view of cutter at *B*, and also a great deal of trouble from variation in length may be avoided by beveling a number of the blanks together and keeping them together until entirely cut. The diameter of the holder at *C* should be just large enough so that the thread tool will clear it.

The slots are cut in the holder so that the blanks come behind the center, and besides are tilted so as to throw the foot of the blank away from the center of the holder about 1-16 inch, as shown at *G*. This tips up the heel of the blank so that in the cutting of the thread sufficient clearance is insured, as is shown in the sketch at *D*. The clearance that is obtained in this way appears to be an ideal clearance for our work, and I see no reason why it should not give satisfaction on any work of a corresponding diameter; that is, on 1¼-inch pipe.

We use these same cutters in our 1, 1¼, 1½ and 2-inch pipe tap. However, in our 1-inch tap, we have to mill our slots a little ahead of the center to get the same clearance on account of the 1 inch being a smaller circle, or the cutters would ride on their heels. The amount which they are placed ahead of center is hardly 1-64 inch, which placing ahead of center will be readily seen to be, in effect, tipping the heel down, or the reverse of the position in the jig at *G*. On our 1½-inch and 2-inch taps we place the cutters slightly behind the center, since if put in on the center the same as in the 1¼-inch tap, there would be too much clearance, when we really want less with the number of cutters remaining the same, which is four.

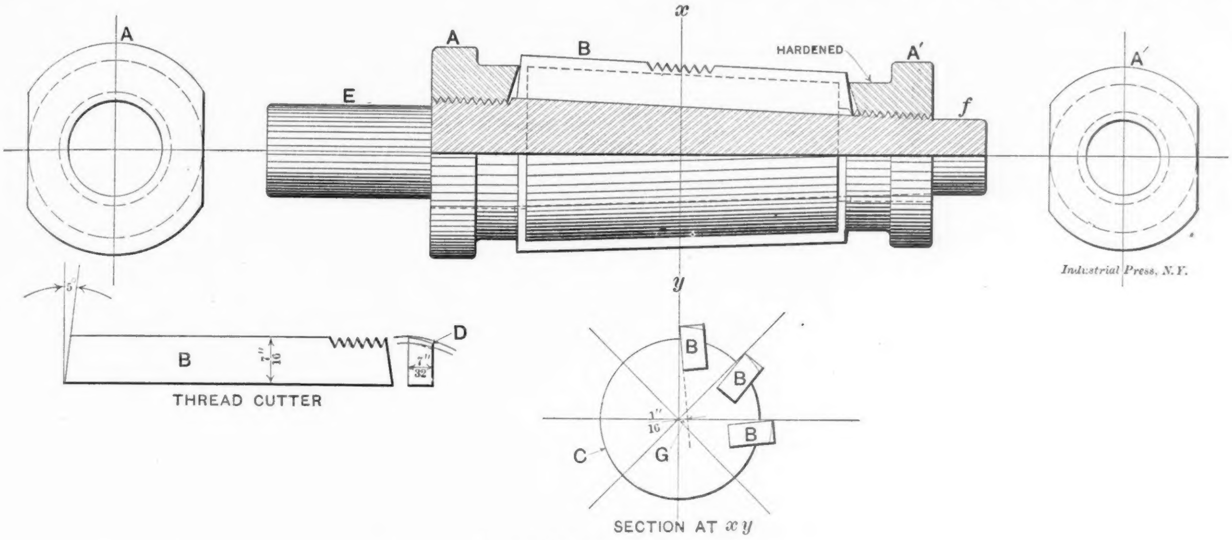
This holder may appear to be very slender, and is, of course, more so at the small end, but we have one in use that has held about 400 sets for cutting, or enough for 800 taps. The end, *E*, is longer than *f*, simply for dogging the holder, being, of course, used on centers.

We use a Reed lathe, with taper attachment and compound slide, and use the Rivett Dock thread tool, finishing a 11½ pitch thread with 13 to 15 cuts, and gaging the size by means

of a set caliper to which the thread is brought to fit at one end. This is a very important feature of this taper work in getting the exact size, as regards the distance to which the tap will enter the work, and especially so in using three-spindle machines for pipe tees, as if the taps go in too far they will come together.

This system of making taps is carried up to sizes as large as 12 inches, some changes in detail being, of course, necessary in the larger sizes. W. J. H.

Providence, R. I.



Jig for Making Thread Cutters.

VALVE GEAR FOR GAS ENGINES.

Editor MACHINERY:

The problem of designing a gasoline engine came to the writer some time ago for solution, in which the engine was to have two cylinders, cranks opposite, hammer-break igniters and adjustable sparks. It was to operate on the four-cycle principle, and run in either direction, not self-reversing,

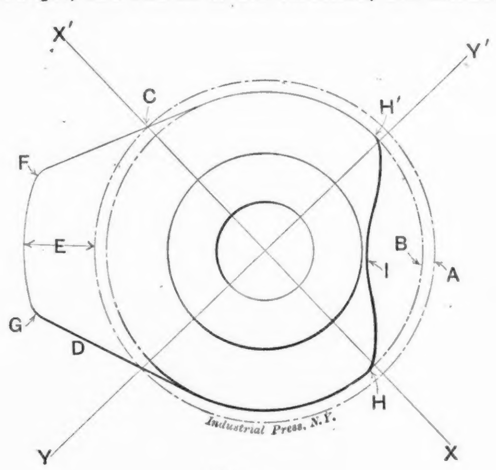


Fig. 1.

but to run in the direction in which it is started. The engine was to be governed by holding the exhaust valves open, on the "hit-and-miss" principle, the igniters being operated from the motion of the exhaust valve push rods, which thus necessitated a special design of valve motion cams.

A novel design of cams was undertaken, which will be described. In the first place, the igniter was arranged to be operated from the valve rod by a finger attached to it which separates the contact points as it moves upward, by lifting up another finger or hammer, and then letting it go, allowing the hammer to hit and separate, the points producing a spark, on the principle of "hammer-break" igniters. In laying out the cams the circle, *B*, was drawn of the diameter of the desired cam, and then another concentric circle, *A*, was drawn slightly larger than the circle, the distance between the two circles representing the "lost motion" travel; that is, the amount of play in the valve push rod and roller. Lines, *X X′* and and *Y Y′*, perpendicular to each other, were then drawn, intersecting each other at the center of the circles. Although it is generally accepted amongst gas engine designers that the proper point for the exhaust to take place is when the piston reaches about nine-tenths of its expansion stroke, still in this case it was necessary to start the exhaust exactly at the end of the stroke on account of the arrangement for the cams to run in either direction, and as it is necessary that the valve should close at the end of the stroke. Therefore, as the lines, *X X′* and *Y Y′*, are taken to divide the circle into four parts to represent the four strokes which constitute the cycle, it is necessary to start at one of them for exhaust to begin at as *C*. Drawing a line through the intersection of the line *X′* and the circle, *A*, and tangent to the working circle, *B*, and another similar line, *D*, gives the eccentric parts of the exhaust projection for both directions. The distance, *E*, equal to the desired lift of the valve was marked off and an arc drawn through that point concentric with the other circles, and then by rounding off the corners where the arc meets the eccentric lines at *F* and *G*, the exhaust portion of the cam was completed. By making the lines, *C* and *D*, tangent with circle, *B*, the easiest possible movement in starting the roller is permitted.

The remaining part of the cam to be laid out was the ignition portion. It is necessary for ignition to take place near the end of the compression stroke either before, or after, or on the dead center according to the compression, speed, etc. The end of the stroke for either direction is at the point *H* or *H′*. The distance from *I* to *B* was laid off equal to the stroke necessary for operating the igniter and the contour of the cam adjusted to take in that depression, the corners *H* and *H′* being rounded past the lines *X* and *Y′* to allow of late ignition if desired. Thus the roller will travel upward from *I* to *H* or *H′* causing the points to come into contact with each

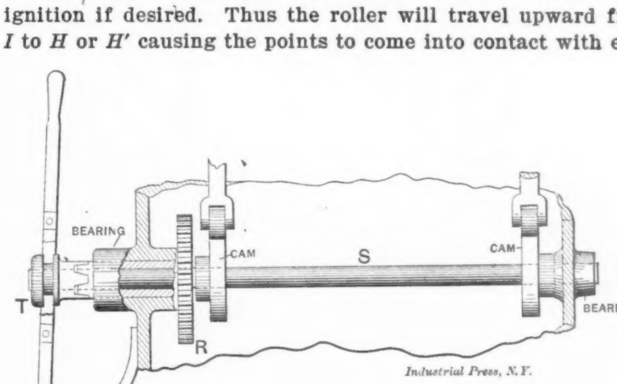


Fig. 2.

other and separate before the roller and rod has reached the highest point. Suction or expansion takes place between *X* and *Y* or *X′* and *Y′*, exhaust between *Y* and *X′* and compression between *X* and *Y′*. It may be seen that this method has the advantage in governing by holding the exhaust valve push rod up, which keeps the igniter out of contact.

In Fig. 2 is shown the method of changing the position of

the cams with relation to the crankshaft by means of a simple clutch. The gear, *R*, is twice the diameter of the driving gear on the crankshaft, as usual, and has a sleeve extension cast solid with it. This gear and sleeve is mounted on the shaft, *S*, running loose on the latter and the end of the sleeve extending out through the bearing has four notches therein to form a clutch. The shaft, *S*, extending through beyond has a clutch or toothed sleeve, *T*, to fit the notches in the gear-sleeve, which clutch slides on the shaft, but is kept from turning by a feather fitted to it and the shaft. By pushing the lever in and causing the teeth of the sleeve, *T*, to engage the notches in the gear-sleeve, the gear will drive the cam shaft, which will cause engine to run in one direction; while by pulling out the clutch and turning the crankshaft one-half turn, or the camshaft one-quarter turn, and then pushing in the clutch again sets the cams for the engine to run in the opposite direction. By pulling the lever out and immediately pushing it in again while the engine is running will cause the clutches to engage on the next set of notches as ignition will simply take place at the outward end of the stroke. The engine was not, however, intended to be self-reversing, but gives satisfaction for what it was designed for.

Oshkosh, Wis. L. J. Monahan.

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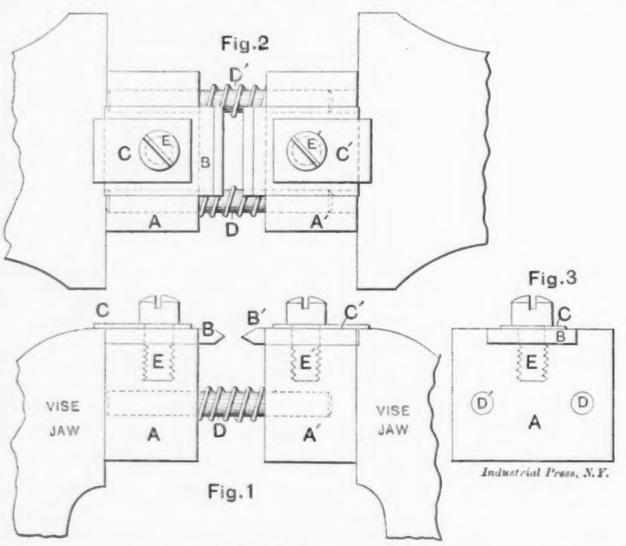
STEEL WIRE CUTTER.

Editor Machinery:

The accompanying diagrams illustrate a convenient cutter for cutting up Stubs steel wire or drill rods. Fig. 1 shows it in elevation, and Fig. 2 in plan, Fig. 3 being an end view of the cutter block. It consists of two cast-iron blocks, *A A'*, into which slots are planed on top to receive the steel cutters, *B B'*, which are fastened with the screws *E E'*, as shown, and it is used by placing it between the jaws of a vise and



Cutter for Steel Wires.

closing up the vise when it is desired to cut. The cutters are guided to move in line with each other by two pins, *D D'*, which are driven tightly into the block *A*, and slide freely in holes in the block, *A'*. Two coiled springs hold the cutters apart normally, as shown. The plates of sheet metal, *C C'*, which are held in position by the same screws that hold the cutters, project back beyond the blocks, *A A'*, and serve to support the device when the vise is loosened. The rear end of each cutter should project back slightly beyond the cast-iron blocks so as to relieve the screws from any strain in cutting.

Meriden, Conn. James P. Hayes.

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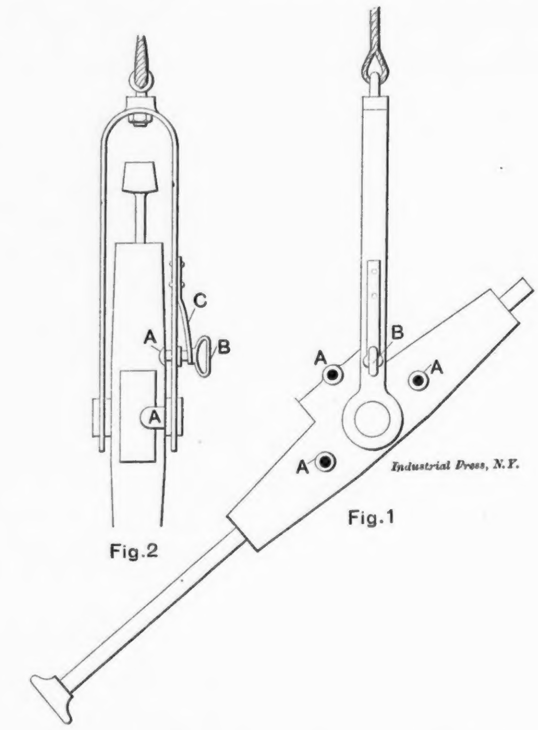
METHOD OF SUPPORTING PNEUMATIC RAMMER.

Editor Machinery:

I send you herewith a sketch of a suggested improvement in the pneumatic rammer. The rammer is usually hung by a flexible support with a counterbalance, so as to adjust the height, but while the man is operating it there is no way to prevent its swinging. In one I have seen working the operator had a rope tied about half way up the barrel, which was a disadvantage, as it required one hand to hold the rope in place, causing the operator to partially lose control of the tool.

The idea shown in the sketch will obviate the trouble, I think. Fig. 1 shows a side view of the tool and Fig. 2 an end view. It will be seen that the bosses *A A A* are cast on



the cylinder and valve chest and are drilled for the locking pin *B*. This pin is supported by a flat spring, *C*, that holds it in place and allows it to be withdrawn easily so as to clear any of the bosses, and the tool can then be tilted into a vertical or horizontal position, as desired, and locked by the pin, which will enter the corresponding hole through the action of the spring. William F. Torrey.

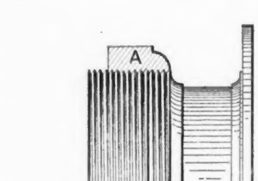
Quincy, Ill.

* * *

COMBINATION CHUCK FOR LARGE RINGS.

Editor Machinery:

The accompanying diagram shows a combination chuck for holding work threaded male or female. It is used for turning large metal cases and also flanged rings to fit upon the cases, and is so designed that if the female work fits snugly upon the chuck, and the male work also fits snugly, the two pieces of work will fit snugly together. It consists of a disc, or chuck, *C*, of the finished diameter and number of threads, and a metal ring, *A*, screwing upon the chuck. For holding male work, as in the case, *D*, the chuck ring, *A*, is screwed out till it projects from the chuck and then the externally threaded portion of the case is screwed firmly inside the ring. For female work, as the flanged ring, *E*, to fit on the case, *D*, the chuck ring is screwed back, as at *A'*, and the flanged ring with internal threads is screwed on the chuck as far as its shoulder, *B*, will permit. In turning the flanged rings, the chuck ring is screwed up, or butted, against their back faces, which helps to prevent the inner flange of the ring, *B*, being buckled out by the strain of turning. In this way the chuck proper is used as a gage for the fitting of the flanged rings while the chuck ring serves for the same purpose



Combination Chuck.

for the cases. This device has also a decided advantage over the ordinary female chuck, as in the ordinary female chuck made solid the case will screw in so tightly that it is a source of trouble to take it out; with the movable chuck ring on this style of chuck the case is very easily removed, as the chuck ring can be "backed off" enough to overcome the locking effect.

J. B. Niemand.

Bridgeport, Conn.

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SWAGING COLLARS ON STUDS.

Editor Machinery:

The tool to be described came into existence a short time ago, after a very heated argument between the officials of the shop where I was employed, as to whether a collar could be swedged onto a piece of wire by driving from the end without heating. Studs of this kind were a necessity and had been made on a screw machine, proving very expensive. The outcome of the argument was the tool shown in the accompanying diagrams, which proved a success.

In making this tool, a block of soft steel, *A*, Fig. 1, was milled in the shape shown, the two sides and ends being milled bevel, as the work was to be done in a stamp and the poppet-screws would then always have a tendency to

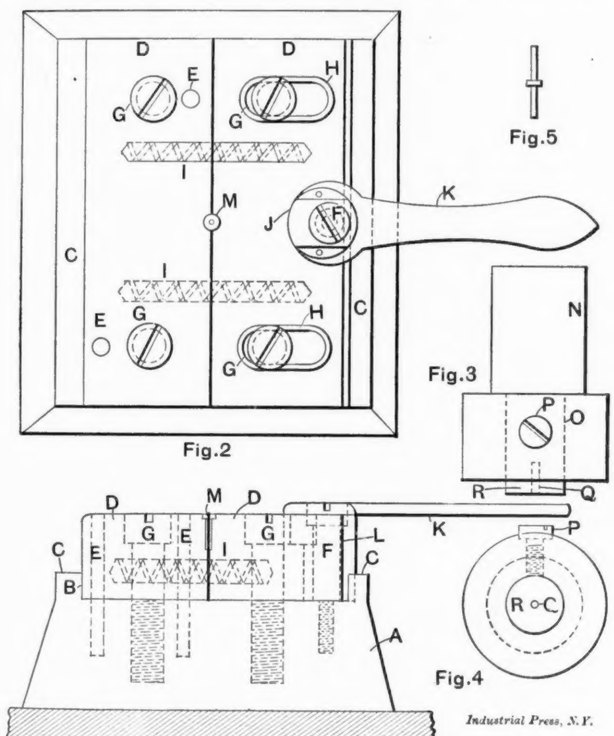


Fig.2 Fig.5 Fig.3 Fig.4 Fig.1

Industrial Press, N.Y.

clamp the tool snugly to the anvil of the stamp. After milling the bottom piece or base, a recess was milled in its top, leaving shoulders, *C C*, on each side, which were to form a backing for the dies that were to be fastened in this recess. For the dies *D D* two pieces of tool steel were milled to the shape shown in the drawing and fastened to base with the screws *G*, the stationary side *B* being doweled at *E* besides, and the screw-holes on the movable side being elongated, as at *H*, to allow the moving of that half of the die after the stud should have been swedged. Holes were then drilled in each die, as at *I*, for the springs, which were open spiral springs, and served to open the dies after they had been released. The hole for the cam was then bored of the desired diameter in the movable die at *J*. As the cam was turned to a close fit, it had a bearing on the die and was backed up by the shoulder at the same time, which did a great deal toward relieving the strain on the screw that fastened the cam in place. When the cam was turned, it was drilled eccentrically 3-16 inch off center, for the screw *F*, which would allow the die to open the desired width. The top of the cam was then milled for the handle *K*, which handle was made the shape of an open-ended wrench to fit over the top of the cam, and was fastened on with dowels. The cam, with its handle, was then fastened into place by the screw *F* and the die was ready to be drilled at *M* for the hole for the stud and then counterbored for the collar on the stud. This completed the making of the dies. They were then, together with the cam, hardened.

The plunger was next taken up. A piece of soft steel was turned with a shank *N*, Fig. 4, to fit the hole in the jack die. The hole *O* was drilled in the bottom of this piece and a piece of tool steel, *R*, was turned to fit in it and was fastened in by the set-screw *P*. A hole was then drilled in center of this plug at *Q* of a size equal to that of the wire to be used, and of a depth equal to the desired length of the stud from the collar to the end opposite the one that enters the hole in the die. This plug was then hardened, which completed the making of the tool.

The tool complete was put into a stamp with a 45-pound hammer, and set by clamping a piece of wire of the size to be used in the hole, *M*, in bottom die. Then the top die was placed in the jack and the hammer lowered for adjusting the bottom die until the end of wire projecting from it entered the hole *Q*. The poppet screws were then adjusted until the bottom die was fastened into position, which rendered the tool ready for use. A piece of the wire was cut 3-32 inch longer than the required finished length and clamped into the bottom die. The hammer was then dropped a sharp blow, which drove the ends of the wire into contact with the bottoms of the holes, compressing it and giving it the desired length and also forming the collar in the correct position. The cam was then released by turning handle, *K*, which allowed the dies to open, and the stud was then taken out finished, as shown completed in Fig. 5. This tool reduced the cost of the product to a very small amount as compared to the cost of making on a screw-machine.

"Notroh."

* * *

THE NEW METHOD OF COMPOUND INDEXING ON THE UNIVERSAL MILLING MACHINE.

Editor Machinery:

As my article on the "New Method of Compound Indexing," in July Machinery, may have been too technical for some of your readers, I will attempt another explanation. I have been brought to this conclusion by several questions which have been asked me by fellow-workmen. Some who are able to calculate the gears are unable to prove them, or are not quite satisfied with the proof given.

It should be thoroughly understood, however, that the new method does not change the relation between the actual turns of the index crank and the revolution of the work spindle. This ratio is always 40 to 1, no matter which way the index plate is geared to turn, or at what rate in relation to the turns of index crank, as 40 turns of the crank with reference to a fixed point brings the spindle once around. This number, 40, is for ordinary cases, divided by the number of divisions required to get the crank movement. For example: Required the crank to move for 80 divisions; 40-80 equals ½, and a half-turn of the crank would give 1-80 of a revolution of the work spindle. Now, if the index plate is geared to the work spindle so as to turn with it, the number of crank turns around the index plate from a given point on the plate will be varied, being either more or less than 40, according as to whether the plate moves in the same direction as the crank or opposite to it. The number of turns of the crank with reference to the index plate which cause one revolution of the work spindle may be divided by the required number of divisions, in order to obtain the crank moves, the same as when the plate is anchored; but when the index plate moves we get the apparent turns of crank, and not the actual turns. By varying the crank turns necessary to produce one revolution of the spindle, many odd divisions can be obtained more easily than by any other method.

To make the explanation clear in regard to the crank turns, let us use for an illustration the hands of a watch: The long hand corresponds to the crank and the short hand to the index plate. Whenever the hands meet may be compared to a revolution of the crank around the index plate. Suppose the hands are together, as at 12 o'clock; how often will they meet during one complete revolution of the short hand, or in 12 hours or revolutions of the long hand?

A little consideration will show why they come together 11 times. The short hand makes one revolution while the long hand makes 12, and therefore one revolution must be subtracted from 12 to get the number of times the hands meet. Suppose there is placed an idler gear in the watch to cause the short hand to move in an opposite direction to the long hand: How often would the hands meet during 12 hours, or revolutions, of the long hand? A little consideration will show that they will meet 13 times. As the short hand makes one revolution in an opposite direction during 12 revolutions of the long hand, one must be added to 12 to get the number of times the hands meet. The same reasoning may be applied to the turns of crank, when the index plate is geared to the spindle. Suppose equal gears are used, and one idler, so that the index plate moves in the same direction as the index crank: Then one must be subtracted from 40 to get the number of times the crank meets the same hole in the index plate, which is 39. If two idlers are used, so that the plate rotates in the opposite direction from the crank, or in a direction opposite the hands of a watch, one must be added to 40 to get the number of times the crank meets the same hole in the plate, which is 41.

The above reasoning will probably be found sufficient. But, for those who are familiar with algebra, the following may be interesting: With equal gears on the spindle and plate, let x equal the turns of the crank from the starting point, until it meets the same hole in the index plate; then $\frac{x}{40}$ = movement of the index plate.

$$\text{Then } x = 1 \text{ turn} + \frac{x}{40};$$

$$\text{clearing of fractions: } 40x = 40 \text{ turns} + x; \text{ whence}$$

$$39x = 40 \text{ turns, whence}$$

$$x = \tfrac{40}{39} = 1\tfrac{1}{39} \text{ turns.}$$

Thus the crank would meet the same hole in plate at 1 1-39 turns. Now, as 40 turns bring the spindle around once, there would be 40 ÷ 1 1-39 = 39 divisions. With the same gearing ratio of 1 to 1, and two idlers in use,

$$x + \frac{x}{40} = 1 \text{ turn (actual, } x = \text{apparent)};$$

$$\text{clearing of fractions: } 40x + x = 40 \text{ turns (actual)}:$$

$$41x = 40 \text{ turns, whence}$$

$$x = \tfrac{40}{41} \text{ turns.}$$

Then the crank pin meets the same hole in the plate at the 40-41 part of a turn.

$$40 \div \tfrac{40}{41} = 40 \times \tfrac{41}{40} = 41 \text{ divisions.}$$

Now these numbers, 39 and 41, can be used for index reckoning numbers to obtain the crank moves for a number of other divisions. Taking 39 for the index number, divide it by any number, and if the quotient, or ratio, can be found among the index circles, that number can be indexed.

For 3 divisions, $\frac{39}{3} = 13$ turns of crank; for 13 divisions, $\frac{39}{13} = 3$ turns of crank; for 57 divisions, $\frac{39}{57} = \frac{13}{19}$ turns of crank, using the 19 hole circle; for 63 divisions, $\frac{39}{63} = \frac{13}{21}$ turns of crank. A number of other divisions also can be obtained. With 41 for the index number, for 123 divisions, $\frac{41}{123} = \frac{1}{3}$ turns of crank, and for 246 divisions, $\frac{41}{246} = \frac{1}{6}$ turns of crank.

Now, if the gearing ratio is 2 to 1, or if a gear with twice as many teeth on the plate as on the gear is placed on the spindle, with one idler, there would be 38 turns of the crank to bring the work spindle once around. If two idlers are used, 42 turns of crank would be required. The same reasoning as given above can be applied to this case; as the ratio is 2 to 1, the plate moves 2-40, or 1-20, as fast as the crank.

Algebraic proof for one idler:

x = turns of crank, for 1 revolution around plate;

$\frac{x}{20}$ = moves of plate:

$$x = 1 + \frac{x}{20};$$

$$\text{clearing of fractions: } 20x = 20 + x,$$

$$19x = 20;$$

$$x = \tfrac{20}{19} = 1\tfrac{1}{19} \text{ turns.}$$

Then, $40 \div 1\frac{1}{19} = 38$ = index reckoning number.

With two idlers: $x + \frac{x}{20} = 1$ complete turn of crank;

$$\text{clearing of fractions, } 20x + x = 20 \text{ turns of crank;}$$

$$21x = 20;$$

$$x = \tfrac{20}{21} \text{ turn of crank.}$$

Then, $40 \div \frac{20}{21} = 40 \times \frac{21}{20} = 42$ = index reckoning number.

For indexing prime numbers, the index reckoning number must be a fractional one. Suppose it is required to obtain 61 divisions: We can obtain a vulgar fraction so that 61 may be contained in the numerator, for an index reckoning number; thus, 2 × 61 = 122. Now divide this by any number, say 3, so that the index number will be near 40; thus, 122 ÷ 3 = 40 2-3. As this number is greater than 40, two idlers will be required, so as to rotate the plate opposite to the crank, 2-3 of a turn, during 40 actual turns of the crank with reference to a fixed point; that is, the index crank would meet the same hole in plate 40 2-3 times during 40 actual turns of crank, or one revolution of the work spindle. And gears in the ratio of 2-3, or 32-48, or 48-72, are required, either of which pairs of gears would do—the numerator, or gear, above the line, on the spindle, and the denominator on the plate.

Now, to obtain the apparent crank moves, as in the previous cases, divide the index reckoning number by the required number of divisions:

$$\tfrac{122}{3} \div 61 = \tfrac{122}{3} \times \tfrac{1}{61} = \tfrac{2}{3} = \tfrac{26}{39}$$

and 26 divisions (27 holes in sector) on the 39-hole circle would be used. The proof for the index reckoning number is the same as in the previous cases. As the plate moves 2-3 of a turn in an opposite direction, the crank must make 40 2-3 turns. Algebraic proof:

x = turns of the crank until it meets the same hole in plate again.

The rate of movement of the plate with relation to the crank $= \frac{\frac{2}{3}}{40}$ or $\frac{2}{3} \div 40 = \frac{1}{60}$ then $\frac{x}{60}$ = moves of the plate.

$$x + \frac{x}{60} = 1 \text{ complete turn of the crank;}$$

$$\text{clearing of fractions: } 60x + x = 60 \text{ turns of the crank;}$$

$$61x = 60;$$

$$x = \tfrac{60}{61}$$

Then $40 \div \frac{60}{61} = 40 \times \frac{61}{60} = 40\frac{2}{3}$ = index reckoning number.

The algebraic proof, while not really necessary, is convenient to use, serving as a check on the calculations. Algebra is a valuable study, and one which, if a mechanic learns, he will be likely to find a use for, as it is of assistance in using formulas which occur so much in mechanical books and papers. It may be self-taught, although with a teacher the progress will be likely to be more rapid.

East Providence, R. I. J. T. GIDDINGS.

* * *

TOOL ROOMS.

Editor MACHINERY:

While much has been written upon machine shop methods and arrangements, there is very little in current literature upon the subject of tool rooms. This is due, in part, probably to the fact that the needs of different shops vary so greatly, and in part to the complex nature of the subject itself. In what follows I would like to present the general features of the problem as they appear to me.

The tool room should have its delivery window as near as possible to the center of shop patronage, as a matter of course, and this window in turn should be as near as practical to the center of the tool room itself.

While there should be no congestion of workmen or boy carriers a gas pipe railing should be swung as indicated in front of the window, so that approach must be in single file and in a common direction, as indicated by the arrow. This avoids "scrapping" over "turns," and promotes a prompt and systematic disposition of each applicant.

The window and shelf should always be wide enough for two, and an understudy or second should be on hand to help out when things are running in bunches.

With grinding drills, oiling tools, sorting material, etc., there is always plenty of work in the average tool room

for a bright boy, and in case of sickness or unavoidable absence of the toolkeeper it is of the greatest importance to have someone on hand familiar with the location of the tools.

It is also self-evident that tools should be grouped around the window in relation to demand, those called for most frequently being nearest. Almost any bright toolkeeper if left to himself will develop this arrangement, as it lightens his labors and follows the line of least resistance.

A tab on the number of times each tool is taken out during a given week would furnish a fair basis for the arrangement. In general we should have an arrangement something like the following, moving back from the window:

TOOLS.

Drills, standard,
Taps and wrenches,
Dies,
Mandrels,
Rosebits,
Reamers,
Broaches, counterbores,
Dogs,
Files and handles,
Snap gages,
C. clamps,
Micrometers,
Pipe taps and wrenches,
Pipe dies and stocks,
Squares,
Straight edges,
Scales,
Jacks,
Snipes,
Belt punches,
Special drills,
Special taps,
Special reamers,
Jigs, etc., etc.

MATERIAL.

Oil,
Waste,
Cord,
Chalk,
Set and cap screws,
Stubs steel wire, etc., etc.

For most of these small tools an angle iron framework should be made as indicated in Fig. 2. This will carry ash shelves 15 inches by 30 inches inclined at an angle of 30 degrees and gouged out to fit particular tools. Having no back it does not intercept the light, and the inclination throws the shelf at right angles to eye's line of vision as nearly as practical and in a favorable position for removing and returning tools quickly.

Checks should be ⅞ inch round with a ¼ inch hole stamped both sides. Pins for them should be straight and incline back about 30 degrees to the shoulder, so that checks will slide back and not readily fall off. For small drills and taps shelves should be drilled so that the tool projects at right angles. Stock may be kept on the top shelf or near the floor, as these extremes are not convenient for regular delivery.

Stocks and large wrenches may stand on end in a rack slightly inclined backward or be laid across pipe supports above the head.

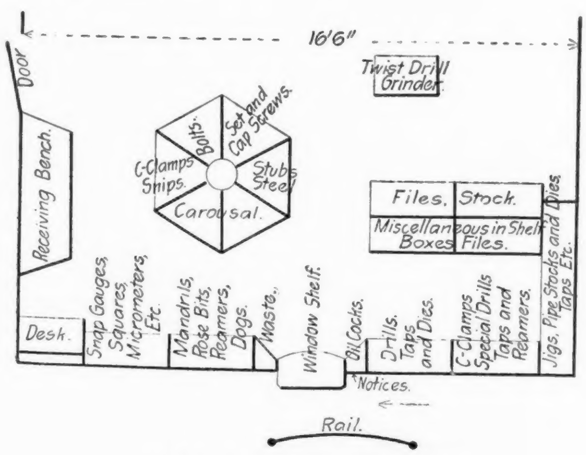


Fig. 1. Arrangement of Tool Room.

Commercial galvanized iron shelf boxes about 6 x 6 x 12 inches will be found convenient repositories for a great variety of special and miscellaneous supplies. Anybody who notes the gain in neatness where these are used in the modern hardware store will appreciate their applicability to much of the shop's small hardware.

Waste should be kept under the delivery window on one side. Oil for squirt cans should be in a tank near the ceiling and be piped to a cock at one side of the window with drip-pan underneath.

The "carousal" or merry-go-round (Fig. 1) has great capacity, being four and a half feet in diameter and seven high. It should be framed of steel and mounted on ball bearings, with a foot brake for stopping quickly, leaving the toolkeeper's hands free to seize the required tool. It will be noted that the general arrangement puts the toolkeeper's desk equi-distant between window and door, with a receiving bench behind him.

The twist-drill grinder, power back saw, rod stock, etc., are near the rear of room.

Stubbs' steel drill and Bessemer rod may be kept in good shape in a honeycomb arrangement of ordinary iron pipe running from 1¼ inches to 1½ inches in size and about 18 inches long.

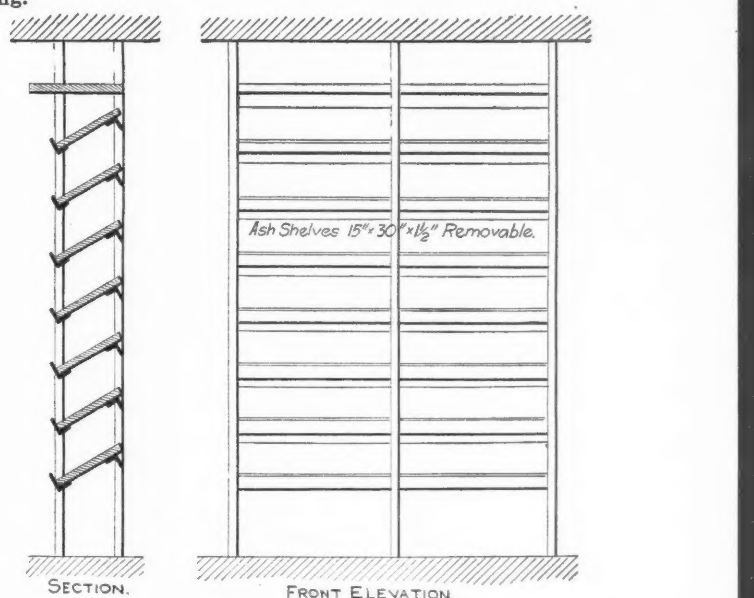


Fig. 2. Tool Rack.

The exact arrangement must be left to the individual toolkeeper and the particular stock, but experience has demonstrated that within this area of a hundred square feet we have considered may be kept a complete complement of tools for the largest shop that could advantageously draw from one point. With the arrangement shown the average walk is cut to little more than three feet, or two steps each way.

When we find an average of two persons waiting, as is often the case, at the tool-room, while the keeper is sauntering off to remote corners for common tools spread out at random, the saving that can be effected here is apparent.

Elmer E. Warner.

* * *

There are a great many hollow metal balls used in water columns and safety devices of various kinds in connection with steam apparatus, and these often give way at the higher pressure now common. Various methods have been adopted for strengthening them internally against this crumpling action of the steam. Some people have used a light metal framework to hold out the sides, but this increases the weight of the ball and therefore destroys to just that extent the buoyancy of the float. Others adopt a simpler plan and introduce a small quantity of water into the interior and when the float is heated from the surrounding water the water on the inside of the float in its turn commences to heat up and give off steam. There will then be an internal pressure to resist the external one, and this will tend, of course, as long as the ball does not leak, to keep the thing in shape and in good working order. I found in a shop down East still another way of getting at this, though on lines somewhat similar to the last method. It consisted in substituting naphtha or gasolene for the water inside the ball. After the ball was closed by the supporting rod, which also acted as a plug, the ball was held over a gas jet and heated. Now if there was any leak it would immediately light up; even the sense of smell might detect it, and this was in that way preferable to the water.—F. O. Reman, in *Iron Trade Review.*

* * *

Recent tests have demonstrated that the simultaneous firing of several heavy guns is heard 140 miles, and that at a distance of 84 miles the reports were so perceptible as to attract attention of people in country districts. At a distance of 61 miles the detonations were so heavy as to jar windows in a manner ordinarily associated with comparatively nearby explosions.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

LATHE FACE-PLATE DRIVER.

O. A. Reich, Mattoon, Ill., has had to turn quite a number of counterbalanced crankshafts, the counterbalances, of course, making one side heavier than the other when turning them in the lathe. Unless the crankshafts are withheld, they fall

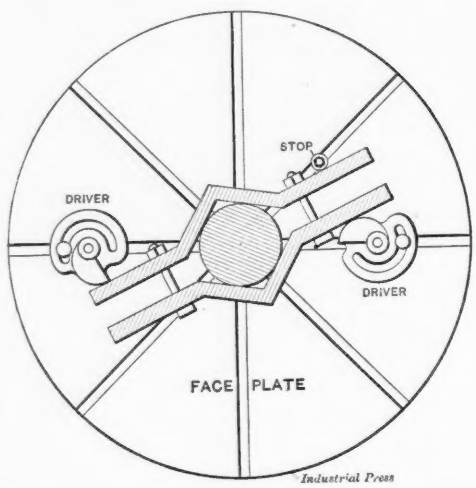


Fig. 1.

forward away from the driver at each half-revolution, which must be prevented. A stop is bolted on the faceplate, and two drivers used in connection therewith which are readily

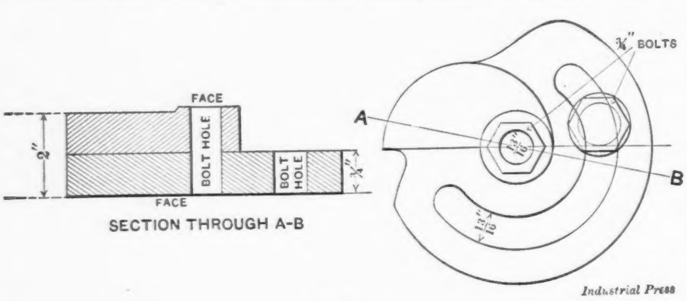


Fig. 2.

adjustable so as to divide the turning moment equally between both arms of the clamp on the crankshaft. Fig. 1 shows the drivers in position, and Fig. 2 shows how they are made. The idea is so obvious that no more explanation is necessary.

TRANSFORMING ORDINARY CALIPERS INTO TRANSFER CALIPERS.

E. E. Cook, Salem, Ohio, sends sketches of a small lathe job which required a transfer caliper for measuring the internal diameter, and the device which was made to allow an ordinary caliper to be used as an inside caliper. The piece shown in Fig. 3 required boring out, and of course a transfer

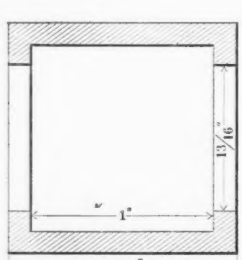


Fig. 3.

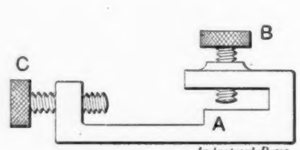


Fig. 4.

caliper was needed to take the size. The old expedient of setting the calipers and then scratching a line alongside of one of the legs to reset them by when removed, was rejected as inaccurate and unsatisfactory when one desires to keep his tools free from scratches. So the device shown in Fig. 4 was hastily made for the purpose. It consists of the frame, *A*, which is held to one caliper leg by the setscrew, *B*. The screw, *C*, is used as a gage, being screwed up to the other leg when the setting has been obtained and employed as a stop when the legs are opened. The device can be used on both inside and outside calipers.

RIG FOR FILING DIES.

J. E. H., Franklin Falls, N. H., sends a sketch of a device which is marked "diemaker's friend," but which is unaccompanied by any description. The cut, however, shows its use so apparently that little explanation is necessary. It is a filing attachment for the lathe for rapidity and accuracy in filing out the interior of dies. The vertical slide to which the file is attached is reciprocated by a crank held in the lathe chuck. From the cut it is apparent that no connecting rod is provided for the slide, so the latter must have a "Scotch" yoke to compensate for the side movement of the crank. The feet of the frame are arranged to set on the lathe bed, and suitable clamps are provided for holding it firmly in position. The work is held on a tilting table.

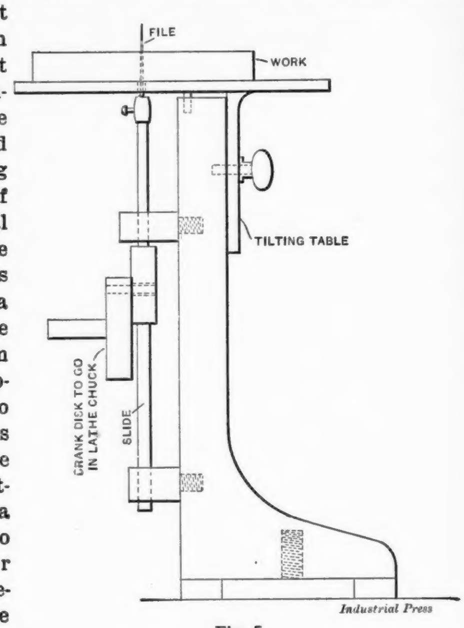


Fig. 5.

REBORING THREADED CYLINDERS.

I. B. Niemand says: "We had a large number of cylinders that we wished to lighten by reboring, but their length, thinness of walls, and the fact that they were threaded on both ends, precluded our doing the work by the ordinary methods, and so we rigged up the device as shown.

"*A* is a cylinder which sungly fits over the outside of the threaded cylinder and screws into the faceplate chuck, *B*. *C* is a locking ring threaded to screw on to the threaded cylin-

Fig. 6.

ders which require turning, and, being held fast between the faces of *A* and *B*, serves as a check nut on the threaded cylinders, which in turn butts up against the face of *B*. The cylinder is consequently held true in the long sleeve, and is prevented from turning by the locking arrangement. The outer end of the sleeve is held in a steady rest.

"We bored between 200 and 300 of these cylinders, and found this device satisfactory."

MISCELLANEOUS KINKS.

"Phos Phorus" sends a kink that he has found very valuable for successfully hardening the heads of cap-screws. He has been troubled, after hardening cap-screw heads to wear under the wrench, with their snapping off on very slight provocation. But he found that, by hardening the heads for about one-eighth inch down from the top of the head only, the trouble is overcome and the heads wear fully as well.

R. W. states that in his work there are a number of hardened pieces to grind which are so large and heavy that they cannot be swung in a universal grinding machine. A very handy and easily-applied device for this grinding was devised by attaching a small dental motor with a surfacing wheel to the cross-feed of the lathe in which the work was swung, and then by setting the motor and grinding wheel at different angles almost any kind of surface work could be ground. For inside grinding, the motor is placed upon a stand at the back about the height of the lathe and its surfacing wheel replaced by a 7-inch pulley with a belt attachment to a grinding spindle held in the tool post. With this arrangement different kinds of internal grinding can be done rapidly and quickly.

A. E. Phillips, Rockford, Ill., describes a punch for cutting oil grooves in the centers of centered lathe work to prevent cutting the centers because of lack of lubrication. It is made from an old three-cornered file ground to a point, as shown.

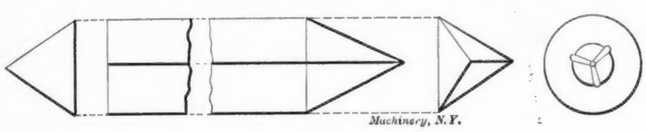


Fig. 7

The temper is drawn down to the blue. By its use the life of lathe centers will be greatly lengthened, especially on heavy work, as they can always be kept lubricated through the three oil-grooves formed by driving it into the center after reaming.

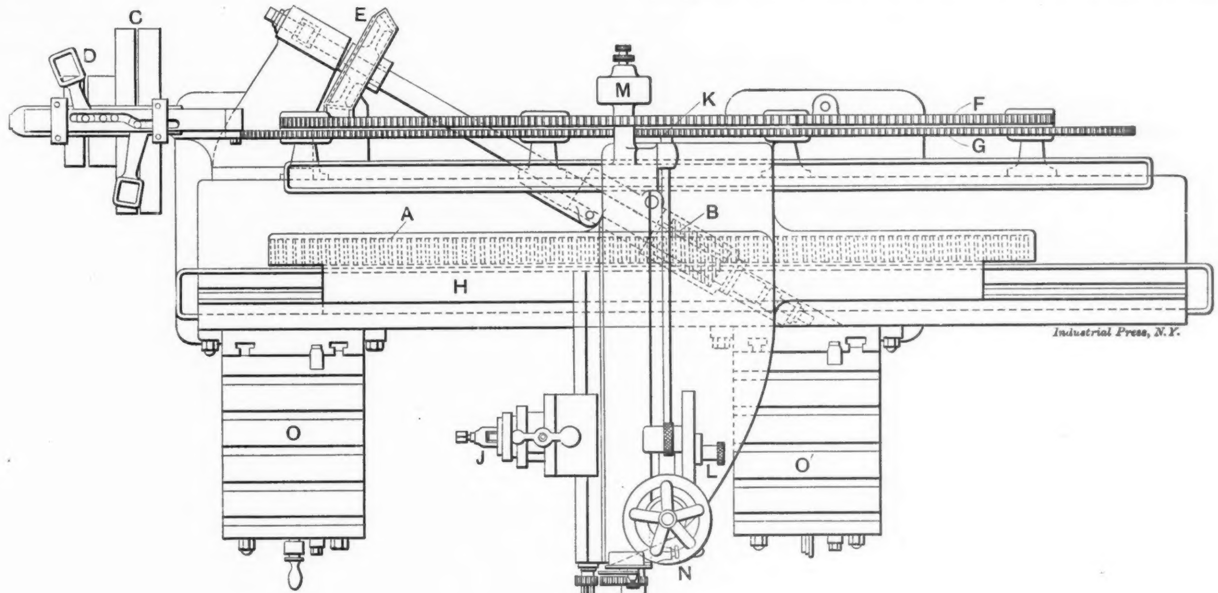


Fig. 1. Plan View of Richards Planer.

IMPROVEMENTS IN THE RICHARDS SIDE PLANER.

A machine tool which is not as well known in the United States as it should be is the Richards side planer. It is a tool against which there appears to be a great deal of unfounded prejudice, since wherever it has been adopted it has generally become an almost indispensable addition to the tool equipment because of its range and adaptability. It occupies an intermediate position between the planer and shaper, having most of the advantages of each, with few or none of their disadvantages. The work remains stationary while operated on by the tool, the same as on the shaper. The range and accuracy of the tool equal those of the planer without the disadvantage of being obliged to reciprocate the work. For this reason it has been found to be particularly adapted to stationary engine building shops for machining large engine frames, etc.

In the first models of this tool the ram carrying the tool slide was operated by a longitudinal screw, the driving and reversing pulleys being mounted directly on it. A recent

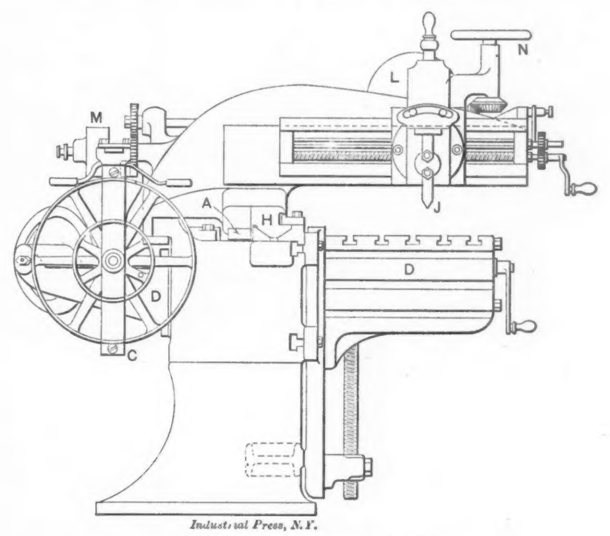


Fig. 2. End View of Richards Planer.

improvement in the design of the driving mechanism does away with the screw and substitutes for it a worm working in a rack the same as the Sellers planer drive. The plan of the machine in the annexed cut shows the arrangement clearly. The rack *A* is attached to the long ram slide *H* and is engaged by the worm *B*. The shaft carrying the worm is driven by bevel gears at *E* from the shaft carrying the driving and reversing pulley *D* and *C*. The rack *G* operates the reversing belt fingers by the arresting of the movement of the pinion *K*. This pinion normally rolls in the rack, but when the ram reaches the end of its prescribed travel stops on the disc *L* prevent its turning further, and therefore the rack is carried along with the pinion far enough to reverse the direction of motion. The function of the rack *F* is to feed the tool on the cross slide by means of a suitable friction box at *M*. The operator controls the movement of the ram at intermediate positions in its travel by the handwheel *N*. *O* and *O′* are the work tables, which are provided with suitable elevating screws.

A RAPID GEAR CHANGING ATTACHMENT FOR AN ENGINE LATHE.

The novelty of a gear arrangement upon an engine lathe whereby any one of its change gears may be substituted for any other upon the lead screw without unscrewing binding nuts, handling gear wheels, etc., cannot fail to be of interest. The engravings, Figs. 1 and 2, present the front and head-stock end views of a lathe so arranged, the gear changing attachment of which involves some very interesting features.

The gear changing attachment consists of a gear box in

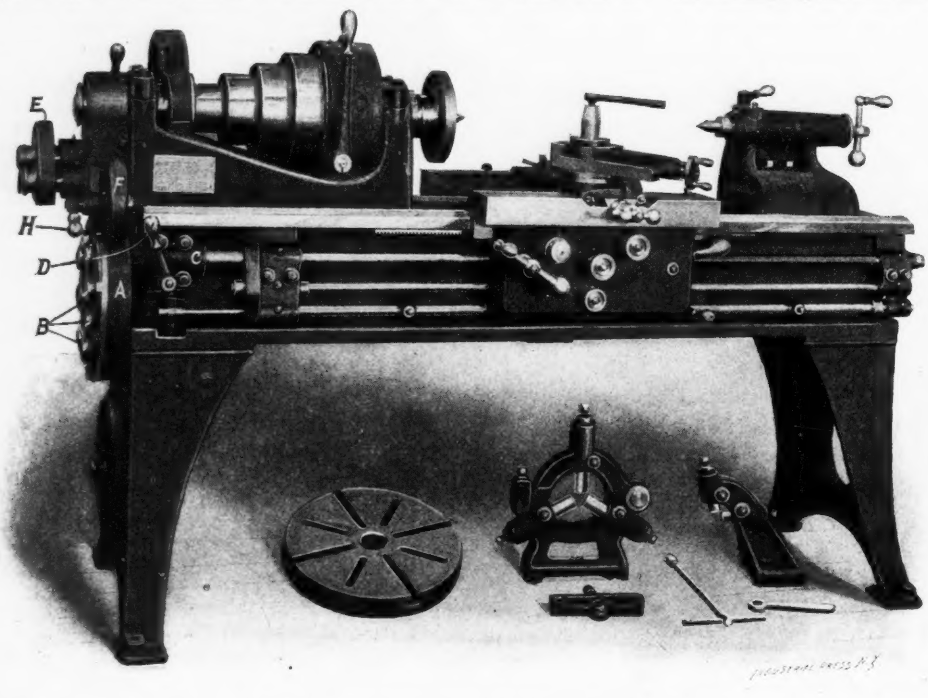


Fig. 1 New Engine Lathe of the Springfield Machine Tool Co.

which all the change gears are mounted, and means whereby the gear box may be readily adjusted so as to bring any desired gear into connection with the lead screw, the intermediate and head-stock spindle gears being the same as in ordinary lathe practice. The gear case, which is shown at *A*, Figs. 1, 2 and 3, is a cast-iron box, the cover of which is capable of rotating about a stud *S*, Fig. 3, at its center, and upon the inner side of which cover the change gears are permanently located. These gears have extension hubs which are fitted into bearings in the case, to allow rotation of the gears, and are held in position in their bearings by the collars *B* on the opposite side of the case. The holes shown in the protruding extension hubs, as at *B*, Fig. 2, are the holes passing through the gear hubs. These bearings in the gear case are so placed that the holes are on a circle concentric with the case, which circle is in line with the center of the lead screw, so that any of the gears may be placed opposite the end of the lead screw by simply revolving the gear case cover.

For connecting any change gear to the lead screw, a clutching device *C*, Fig. 1, is provided, which consists of a telescopically arranged extension of the lead screw shaft. This extension *F*, Fig. 3, which is moved by lever *D*, is reduced at its end to enter the hole in the change gear, a distance equal to its width, before the clutches with which the change gears and the extension are fitted, come in contact with each other. Thus, when one of the change gears is connected with the lead screw, it ceases to depend on the disc for support, but is mounted on the lead screw as substantially as if secured to same by nut and washer. To connect a gear upon the lead screw it is simply necessary to adjust that gear by revolving the gear case until the hole in its hub comes in line with lead screw and then throw the clutch handle to move the extension out to lock with the gear. For ease of adjusting the gear in front of the lead screw a line is cut on the gear case cover which corresponds with each gear, so that by moving the cover until the desired line coincides with a reference mark on the case, that gear is in line with the clutch ready to be locked. By the mounting of the change gears upon the inside of the gear case an efficient guard is provided to protect the gears from dirt or injury, all the eight gears being concealed except at the top where the intermediate gear *F*, Figs. 1 and 2, meshes with them.

Since a sufficient range of feeds, or screw pitches cannot be obtained by changing gears on the lead screw only, a set of three pairs of gears are provided for attachment at the head-stock to vary the speed of the intermediate gear. These pairs of gears, one of which is shown at *E*, are each arranged in small gear cases in a manner similar to the arrangement of the change gears in the case, and are attached and clutched to their spindles by simply slipping them on until their clutches engage the spindles having reduced-end-section clutches similar to the lead screw. These pairs of gears afford the following speed ratios: 1 to 1, 2 to 1, 4 to 1, and, when the latter two are reversed, 1 to 2 and 1 to 4, thus giving five different speeds to the fixed pinion which meshes with the intermediate gear. The arrangement of these pairs of gears in individual cases makes them very handy for placing in gear or removing, and space for those not in use is afforded in the locker *L*, Fig. 2. The intermediate gear, which revolves on a fixed stud on the quadrant to which the handle *H* is affixed, is removed from mesh with the change gears before changing them, by lifting the quadrant. The quadrant has a projection on its lower side, which is machined to the pitch radius of the intermediate gear, and as the same provision is made on the gear case for each of its gears, it is only necessary to drop the intermediate gear until these surfaces meet, and then secure same with clamp lever when the desired gear is clutched in position on the lead screw.

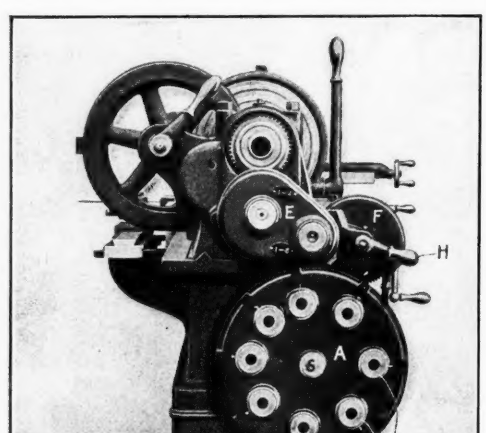


Fig. 2. End View of Lathe.

The range of threads that can be cut on this lathe is from 2 to 56 per inch, and a turning feed from 8 to 224 turns per inch. Every change required to cut any of the threads or

feeds between the extreme limits can be made while the lathe is in motion.

This lathe is made by the Springfield Machine Tool Co., Springfield, Ohio. Besides this novel gear changing attachment, it has several other distinctive features. It has a reverse motion operated at the carriage, an automatic stop for

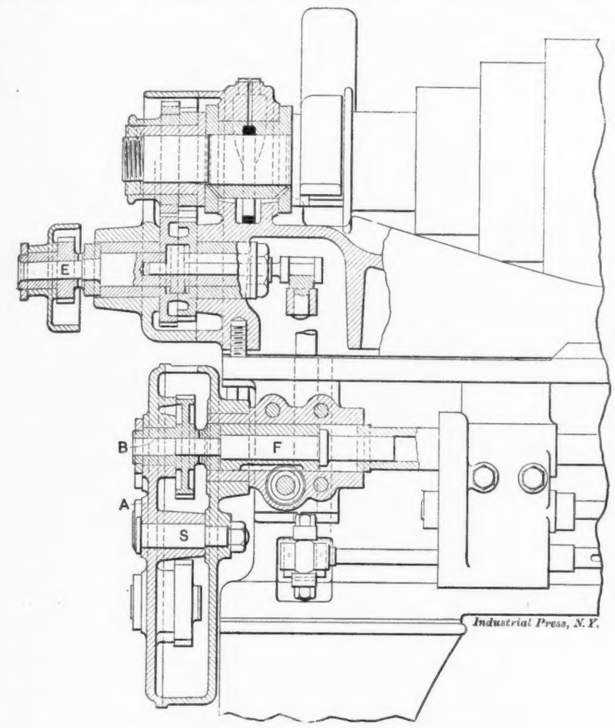


Fig. 3. Detail of Change Gear Mechanism.

turning and screw cutting, and a friction geared head spindle. The friction spindle gearing is similar to that which has proved so indispensable on turret lathes, and adds as many advantages to the lathe.

* * *

COURSE OF STUDY IN SHOP PRACTICE.

It is not frequently the case that we make specific recommendations in our reading columns concerning the purchase of any commodity which is on the market and for sale at a profit. We are quite willing, however, to make an exception in the case of the course of study in machine shop practice that has just been prepared by the International Correspondence Schools, Scranton, Pa., and which is now ready for the enrollment of students. This course of study is a commodity in the sense that it is for sale, presumably at a profit, but it none the less meets with our heartiest approval.

The complete course includes instruction in general machine shop work, and in addition tool making, pattern making, forging and foundry work. Instruction in any one of these departments may be had, or in all of them, as desired by the student.

We have examined the papers that make up the complete course and believe them to contain the best and most complete treatment of shopwork that has appeared. The papers are issued in a large number of sections of perhaps 40 pages each, and these, when bound in book form, as supplied to the students, make four large volumes with contents as follows:

Vol. 1.—As much arithmetic as is necessary to understand the subjects of the course; a paper on reading working drawings; one on measuring instruments, and five papers on lathe work.

Vol. 2.—Papers on working chilled iron; planer, shaper and slotter work; drilling and boring; milling machine work; gear cutting.

Vol. 3.—Papers on grinding; bench, vise and floor work; hints on shop practice; tool-making in six papers.

Vol. 4.—Patternmaking in four papers; foundry work in six papers; blacksmithing in four papers, including soldering, brazing, etc.

We are informed that in the preparation of these papers, including revision, etc., no less than 60 people have been engaged, of whom 20 are specialists in their respective lines. The papers explain methods of doing work, make clear all machine shop calculations likely to arise, and contain descriptions of many labor-saving devices, methods, etc., of great utility. The illustrations are numerous and were made especially for this course. They are in the same style that has been used by the International Correspondence Schools from the first; that is, they are pen and ink drawings, most of them in perspective, and are superior to any similar illustrations with which we are familiar. There are also many useful reference tables.

It is our impression, in looking over these papers, that here is a favorable opportunity for mechanics, and especially young mechanics. We have expressed ourselves in another part of this month's number as believers in skilled and well-informed mechanics. We believe the chance for the employment and advancement of such is so good that it will pay a mechanic to try to become a skilled and well-informed workman, and also that such a one is the kind that it pays manufacturers to employ. It is a considerable problem for any mechanic, however, to know how to become a skilled workman. Formerly an apprentice was bound out and had the opportunity to learn all branches of his trade. Then he became a "journeyman"; that is, he journeyed from one town to another, working in different shops and picking up valuable information. To-day there are several times as many subjects to be mastered before one can become an "all-around" machinist, as was required a few years ago, and unfortunately few apprentices have as good a chance as formerly to master even the few things that were supposed to make up a machinist's store of knowledge in times past. The tendency is towards specialization and too often a man is kept on one or a few lines of work until he becomes virtually a part of the machine on which he is employed.

Take the case of a milling machine hand. Often a man will work for years on a milling machine without understanding what the machine can actually accomplish, and without knowing how to make the calculations for spirals or for indexing. He may not even understand how to set the machine for any except the jobs with which he is familiar, this work being done by the foreman in charge. Much less, also, will the milling machine hand understand about other work. He may know nothing about grinding machinery, toolmaking and tempering, and the set-up for chucking and screw machines; the erection of machinery and many other lines of work will be unknown quantities to him.

What hope is there of such a one pushing ahead to a position of greater responsibility? His only hope is to find out about these various subjects, somehow or somewhere, and make himself master of them. It is for this reason we say that in a course of study like the shop course offered by the International Correspondence Schools is an opportunity for mechanics. A machinist is primarily a hand operator. He must become skillful with his hands and be able to do fine or rough work, as the case demands, within a reasonable length of time, and this much can be acquired by any careful and diligent man or boy. Beyond this, however, the machinist, if he is to advance, must become a mind worker. He must know about things, he must be a student of shop operations, an observer, and we believe we are not wrong in advising that he become a student in a good correspondence course.

* * *

On July 7, William W. Tucker, of the firm of W. W. & C. F. Tucker, Hartford, Conn., died at his home in that city. He was born in New Britain in 1838, and at the age of 19 became superintendent in a shop at Brookfield, Mass. He was afterwards employed by Cottrell & Babcock, now C. B. Cottrell Sons. Later he entered the employ of the Pratt & Whitney Co., of Hartford, and remained with that company about thirty-seven years. He then went in business for himself. He was the inventor and patentee of many parts of automatic screw machines, some of which he assigned to the Pratt & Whitney Co.; and he received from them for a number of years royalties on many of his inventions. Mr. Tucker was also the inventor of several labor-saving devices for use in bicycle machinery.

MILLING MACHINE FEED MECHANISM.

In our description of the Pan-American Exposition, published in the July number of MACHINERY, reference was made to the positive feed mechanism of the milling machines exhibited by the Cincinnati Milling Machine Co., Cincinnati, O., and it was stated that we should publish a description of the device in a future number.

The features incorporated in this mechanism are:

a—A positive gear-driven feed.

b—A great range of feed changes.

c—A means for changing from any one rate of feed to any other rate of feed conveniently and without stopping the machine.

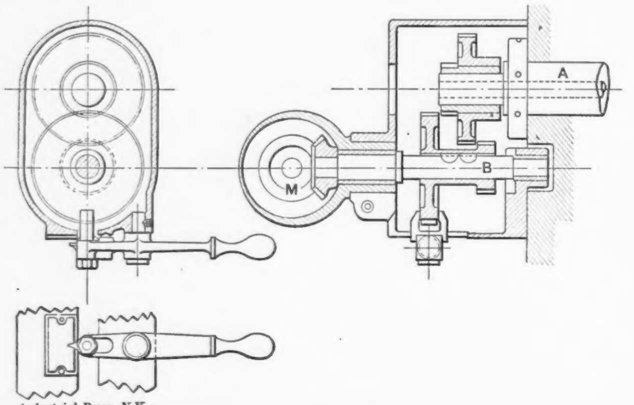


Fig. 1. Mechanism at end of Spindle.

Part of the feed mechanism is placed at the rear end of the milling machine spindle and part is encased in a feed box at the rear of the column. The connection between these two parts of the mechanism is by means of a vertically inclined shaft.

Fig. 1 shows the mechanism at the end of the spindle, *A* being the spindle. Motion is transmitted to shaft *B* by sliding the gears on *B* so as to bring either one of them into mesh with the proper gear on *A*; or the gears may be set in the intermediate position shown in the sketch, in which case no motion is imparted to *B*. This position of the gears throws out the entire feed mechanism. The shaft *B* drives

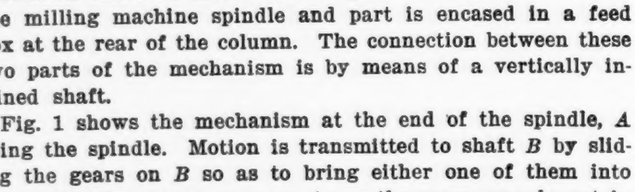


Fig. 2. Feed Cones at Rear of Column.

the shaft *M*, which passes down at an angle and drives the horizontal shaft *C*, which has two spur gears, as shown in Fig. 2. The mitre gears on *M* are of steel, casehardened.

Shaft *D* carries two cones of four gears each, running loose on the shaft and driven independently by the gears on shaft *C*, the larger gear on *C* engaging the smallest gear on one cone, and the small gear on *C* engaging the largest gear on the other cone, thus imparting widely different speeds to the two cones.

The intermediate gear *E*, which slides on shaft *F*, can be brought into mesh with any one of the eight cone gears on shaft *D*, and from it motion is carried to the various feed screws. Gear *E* is brought into mesh with any one of the cone gears by shifting the two levers shown in Fig. 2. The lower lever slides the gear along the shaft *F* to the desired position by means of the toothed sector *a* and the rack *b*, while it is brought into mesh with the corresponding gear by shifting the upper lever, which moves the entire lower portion of the mechanism. This is accomplished by means of a helical groove *c* on the hub of the lever, which engages the pin on the slide *R*, carrying the gear *E* and shaft *F*, as shown.

By means of this mechanism sixteen different speeds are imparted to the feed shaft *F*, advancing by even gradations from 0.004 inch to 0.250 inch for each turn of the spindle. The rate at which the machine is feeding is indicated by the position of the lower lever by means of raised figures on the lever quadrant. This enables anyone to tell at a glance just how fast the machine is working.

From the foregoing it is plain that by simply shifting the levers on the feed mechanism, any one of the sixteen different rates of feed may be obtained, and a change from any one rate of feed to any other may be made without stopping the machine, since there are no change gears to interpose nor belts to shift. Any one of these rates of feed may be used in combination with any of the sixteen different spindle speeds, providing, in all, 256 different combinations.

The spindle speeds vary from 9 to 350 turns per minute and have been chosen with a view to secure the proper cutting speed for cutters of standard diameters. The table shows how well this has been accomplished and also shows how these speeds are obtained for the No. 3 Universal machine.

Table of Cutter Diameters adapted to the Spindle Speeds furnished on the No. 3 Universal Cincinnati Miller.

Spindle Speeds. Revolution per Minute.	Steel. Surface Speed, 20 feet per Minute.	Cast Iron. Surface Speed, 40 feet per Minute.	Brass. Surface Speed, 60 feet per Minute.	Cone Step for Belt.	Counter-shaft, Fast or Slow.	Back Gear, In or Out.
	Inches.	Inches.	Inches.			
9	8½	....	....	First	Slow	In
13	6	12	....	Second	Slow	In
15	5	10	....	First	Fast	In
19	4	8	12	Third	Slow	In
22	3½	7	10	Second	Fast	In
30	2½	5	7½	Fourth	Slow	In
34	2¼	4½	6¾	Third	Fast	In
51	1½	3	4½	Fourth	Fast	In
60	1¼	2½	4	First	Slow	Out
88	⅞	1¾	2⅝	Second	Slow	Out
103	¾	1½	2¼	First	Fast	Out
133	⅝	1¼	1¾	Third	Slow	Out
150	½	1	1½	Second	Fast	Out
203	⅜	¾	1⅛	Fourth	Slow	Out
230	⅜	⅝	1	Third	Fast	Out
350	¼	½	¾	Fourth	Fast	Out

This feed mechanism is one of several new features adopted for the back-geared machines made by this company. The machines have been increased in weight, and provision is made for clamping the knee to the column and the saddle to the knee, insuring rigidity when the longitudinal feed is used.

* * *

The new battleship "Maine" has been successfully launched from the yards of the William Cramp Ship and Engine Building Co., at Philadelphia. The "Maine" is 56 per cent finished. Her keel was laid in April, 1899, and she is to be ready for transfer to the government in eighteen months' or two years' time, depending upon the delivery of her armor plates. The "Maine" is a sister ship of the "Ohio," recently launched at the Union Iron Works, San Francisco, and of the "Missouri," building at Newport News. She is 388 feet long on the water line, 72 feet 2½ inches extreme beam, 23 feet deep, and will have a displacement of 12,230 tons. She is to have a speed of 18 knots an hour. The main battery of the ship will consist of four 12-inch and sixteen 6-inch guns. Besides this, she will carry eight 14-pounders, eight 3-pounders and eight 1-pounders, and machine guns.

* * *

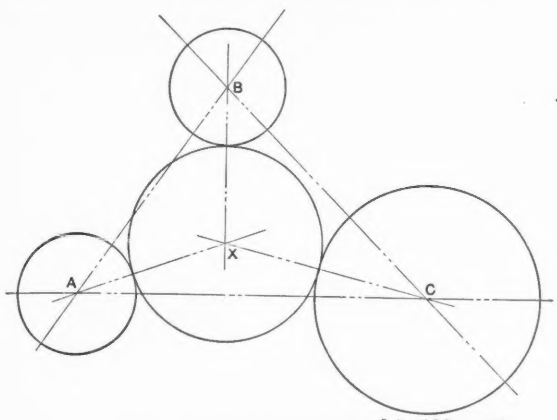
J. M. Westmacott, of Providence, R. I., a well-known manufacturer of gas furnaces, died suddenly on August 20th. It is probable that the business will be continued by the estate.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published

"E. Lind" sends a sketch illustrating a problem in gearing which he would like to have submitted to our readers for a mathematical solution. Given the two gears of same diameter with centers at *A* and *B*, and third gear with center at *C*,



Industrial Press, N.Y.

Geometrical Problem.

also given the distance from center to center of each of these three. Deduce the formula for obtaining the diameter of the gear which will mesh into all three given gears. Suppose, also, we have three gears of different diameters, so as to make a general case of it.

BABBITTING BOXES.

Chas. M. Spencer, Philadelphia, Pa., writes:

In the June number of your paper, Questions and Answers, page 56, I note that C. E. B. asks for information that will assist him in babbitting boxes. Heating is a very good thing; and also I think he will find it well to vent the box at each end. Most men, when they babbitt a box will stop every crack as tightly as they can, which makes the box air-tight, while the air must, on the contrary, be allowed to escape to make room for the metal. I always take the end of my scratch-awl and put it at the end of the box. Then I putty around it and draw out the scratch-awl carefully, so as not to break away the putty from the rest. Like C. E. B., I used to have some trouble with babbitting boxes, but after venting all trouble ceased.

1. S. M. D. M.: When using punches for punching cold steel and iron we find it difficult to punch pieces that are thicker than the diameter of the punch. Can you explain the difficulty and give a remedy? 2. What is the best method of holding feathers in shafting where the sudden strain is great? Should the feathers fit tight on the end? 3. Which is best, to straighten a shaft by pening or by bending it under a press? Also is it best to heat the shaft when bending it?

A.—Assuming that the material used for the punch is suitable to operate on the work that is to be punched, the main thing is to have the punch guided firmly and accurately in a straight line to prevent side strain. 2. It is best always, with either a feather or a key, to depend entirely on the side fit to sustain the strain. When a feather or a key is proportioned properly for its work and fits snugly on its sides, it will cause very little trouble unless the hub in which the shaft fits is too loose on the shaft. In the case of a hub being keyed to the shaft the latter should be forced into the hub or else the hub should be clamped to the shaft. A setscrew should never be put through the hub to bear on the key, nor should it be placed diametrically opposite the key. If setscrews must be used there should be two of them, and so spaced that the key and each setscrew will be 120 degrees apart. In case of a feather where the hub must slide on the shaft it is not possible to secure so great a degree of rigidity and there is always the possibility of trouble. 3. It is better to bend the shaft under a press. Pening affects the surface of the shaft only, and when this surface is turned off the shaft will spring again to a greater or less extent. Cold bending answers every purpose.

2. H. Y.: Kindly published rules for finding the weight of castings by measuring the patterns and also the weights of forgings by measurement.

A.—The finding of the weight of castings from patterns is a matter of difficulty since the weight of the patterns varies so widely. To find the weight of a casting made from white pine, multiply the weight of the pattern by 16; if yellow pine, by 12. This, of course, applies only when the pattern has no core prints—the casting being a duplicate of the pattern as regards weight. A better method, where the pattern is small enough to be conveniently handled, is to place it in a box of convenient size and fill in around the pattern with sand, shaking it down well and filling the box completely to the top. Then remove the pattern and level the sand so that the cubic contents may be readily calculated. Thus, if the box is 20 x 30 inches and the sand levels to 5 inches from the top after the pattern is removed, the cubic contents represented by the pattern would be $20 \times 30 \times 5 = 3{,}000$ cubic inches. Multiplying this amount by the weight of one cubic inch of cast iron—which is 0.26 pound—gives 780 pounds as the weight of the casting made from the pattern. In this case also the casting must be a duplicate of the pattern. If there are core prints they must be allowed for. To find the weight of a forging by measurement, multiply the number of cubic inches by 0.28, which will give the result in pounds, since the weight of a cubic inch of wrought iron is 0.28 pound.

3. H. B.: Please give me the receipt for making yellow pattern varnish in small quantities. 2. What is the principle of the Wellsbach gas mantle?

A.—Patternmakers' yellow shellac varnish is made by dissolving stick shellac in either wood alcohol or grain alcohol. The latter is the better and the more expensive. The common orange shellac is used, which gives the yellow color. Bleached or white shellac is not as good for the purpose. 2. In the Wellsbach lamp a Bunsen gas burner is used in which air is combined with the gas before burning. This makes a blue flame, which is very hot, but which gives very little light. Above the flame is hung the mantle consisting of a fabric that has been steeped in salts of some refractory earth. When the mantle first ignites the fabric burns out and leaves the refractory material, which then becomes incandescent through the intense heat of the blue gas flame. It is this incandescence which gives the light. Several compounds of refractory material may be used for the mantle, and for a list of these and the proportions in which the various elements are used we refer you to "Practical Gas Fitting," by Hasluck, a book which sells for a dollar.

4. J. W. D.: 1. When patterns have to be made for a new machine is it good practice to make one drawing for both the patternmaker and the machinist to work from? That is, should all dimensions be put on one drawing, or should a separate one be made for the patternmaker? Which is the most common practice? 2. When a draftsman makes a drawing which has to be machined to size should he put the finished sizes on the drawings without allowing for the amount of stock to be removed in finishing, or should this allowance be made by the patternmaker?

A.—It is very convenient for the patternmaker to have full-size pencil drawings furnished him of the details of machines, from which to work. This practice, however, is not generally followed, and when the drawings are carefully made there is really no need of it. The patternmaker has in any case to lay out the dimensions to full scale on the wood from which the pattern is made. It is very nearly as easy to do this by taking the dimensions from the drawings as by measuring directly from the full-size drawing. The method to be followed depends somewhat upon what the class of work is. Where a machine is to be designed and only one or a very few of the machines are to be built, it is best to put all the dimensions on the drawing, including both the dimensions of finished surfaces and of surfaces that are left rough, the radii of the curves of the castings for the benefit of the patternmaker, etc. Where a machine is to be built in quantities, however, it is best to put only the finished dimensions on the drawing, as a drawing made in this way is less confusing for the machinist, who will have to use it over and over. A blueprint can then be prepared especially for the patternmaker by adding to it the dimensions that he will need. 2.

It is customary for the patternmaker, and not the draftsman, to make the allowance for the metal to be removed in finishing. The amount to be allowed will depend first upon the capacity of the machines in the shop to remove metal, and secondly upon whether the castings themselves are strong enough to withstand a heavy cut. The custom is growing more and more to allow for the removal of considerable stock and to have machines heavy enough to take off this stock with one or two cuts. The practice of allowing a very small amount for finishing means that more time must be taken for setting up the work and for laying out, preparatory to machining; and that, even then, it may be difficult to get under the scale with the cutter or tool and that the total loss of time will more than offset any loss coming from removing a larger amount of metal.

Answered by Wm. Baxter, Jr.

5. X. Y. Z.: What is the cause of the zincs in a Leclanche cell becoming coated with a white slimy substance which causes the battery to cease working? I have four cells used for lighting the gas. The batteries do not last more than about three months after being charged. On examination I find that the zincs are coated with a white substance, and if this is removed they will work well for a short time and will then become coated again, and finally the carbons will become coated.

A.—The substance that deposits upon the surface of the zinc is a chloride of zinc. The cause of its depositing is that the solution becomes so diluted that it is not capable of dissolving the salts. The cure is to make the solution stronger and use more cells in parallel so as to reduce the strength of current through each one. The trouble may also be caused by not having the connections between the plates and the terminal pieces clean and as perfect as possible. Care should be taken to have the contacts at these points very clean, and the upper end of the carbon and zinc and also the top of the jar should be covered with melted wax or paraffine to prevent the salts from creeping and thus short-circuiting the cell. If short circuits develop the cells will soon run down even if the normal work required of them is light. We would advise you to try "dry cells." They can be obtained from any dealer in electrical supplies and are very cheap, perfectly clean, and give no trouble.

* * *

MINIATURE MICROMETER.

A miniature micrometer caliper, designed for a watch charm, is illustrated herewith. It is only 1 inch in length, is 14 carat gold filled, and the manufacturers, the Sterling Watch Tool Co., Rochester, N. Y., guarantee that it will wear for twenty-five years. The anvil is adjustable for all

Fig. 1.

Fig. 2.

wear, and this small caliper is in every respect a good measuring instrument. The anvil and point of the spindle are of 10-carat solid gold, and take the place of the hardened steel tips on the regular micrometer. The 10-carat gold is much harder than the 14-carat; and the wear therefore is reduced to a minimum, as the points are of solid gold and show no perceptible wear. It will measure accurately in thousandths of an inch, all sizes less than three-sixteenths. The metric measure is also applied to this diminutive caliper, although the manufacturers state that English measure will always be sent unless otherwise ordered. It is sent in a velvet-lined leatherette case, and the price of caliper and case is $2.50.

* * *

This number of Machinery is the first issue of Volume VIII. The index for Volume VII. is now ready for distribution and will be sent free of charge to any subscriber applying for it. Address the Industrial Press, 9-15 Murray Street, New York City.

NEW TOOLS OF THE MONTH.

Under this heading are listed new machine and small tools when they are brought out. No tools or appliances are described unless they are strictly new and no descriptions are inserted for advertising considerations. Manufacturers will find it to their advantage to notify us when they bring out new products, so that they may be represented in this department.

A neat tool has been brought out by the L. S. Starrett Co., Athol, Mass., for use on electrical instruments and other small work. The tool is a screw driver which is also a screw placer. The point of the screw driver is split, making two spring blades similar to the nibs of a drawing pen. In using, the blades are compressed and introduced into the slot of a screw, when the latter will be held by the outward spring of the blades. The screw can then be placed in position and given two or three turns and finally driven home with a solid screw driver.

AUTOMATIC CHUCKING MACHINE.

The automatic chucking machine illustrated in Fig. 1 is one of the new tools exhibited at Buffalo by the Cleveland Machine Screw Co., Cleveland, O. It operates upon castings or forgings held in the chuck of the lathe and has a capacity for work up to 18 by 18 inches.

The machine has four changes of spindle speed, two with open belts and two through the use of back gears. Changes in feeds range from zero to the highest required. It is full automatic in all its movements, including changes of feed

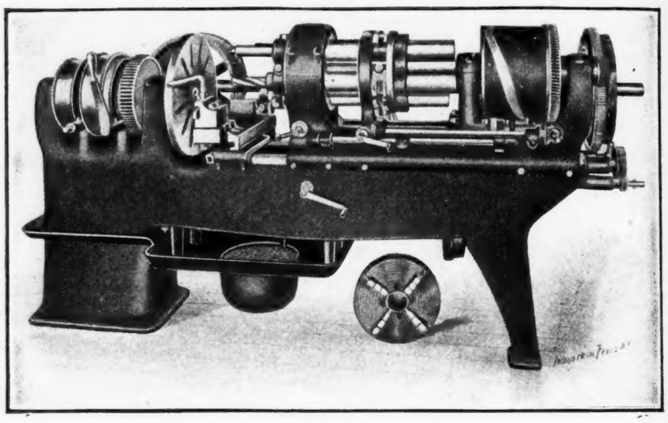


Fig. 1. Automatic Chucking Machine.

and spindle speed, and it is designed so that each tool can have the maximum feed and periphery speed of work that it can stand. There are five tool spindles carried by a disc which is capable of rotating in the frame or head that supports it, as clearly shown in the illustration. Each spindle is advanced in turn at the required speed and is then withdrawn and the disc rotated until the next spindle comes in line with the lathe center. The movements are obtained through the two cylindrical cams at the rear end of the machine. The cross slide, with tool posts front and back, operates automatically through a cylindrical cam at the rear of the head stock. The frame is rigid and is supplied with an oil drip pan and oil well, allowing a bountiful supply of oil to be used when the work requires it. The idea of applying the automatic principle of the screw machine to a chucking machine for operating upon work held in the chuck is an important step in the direction of cost reduction in machine work, and machines that have been designed for this purpose are a noteworthy advance in the development of machine construction.

CRANK SHAPER.

The Prentiss Tool and Supply Co., New York City, have brought out a new crank shaper, which, although embodying the essential features of their older shaper, has several points of distinct advantage over it. The engraving, Fig 2, is a view of the 26-inch stroke size of the new shaper, which machine is on exhibition at the Pan-American Exposition. A changing plate, shown conveniently located at the side of the machine, was mounted on it by two studs carrying com-

pound gearing by which it is possible, by simply throwing in mesh one or the other of them, to obtain eight changes of speed from a four-step cone, thus allowing quick motions for brass and other soft metals, or the regular speed. A

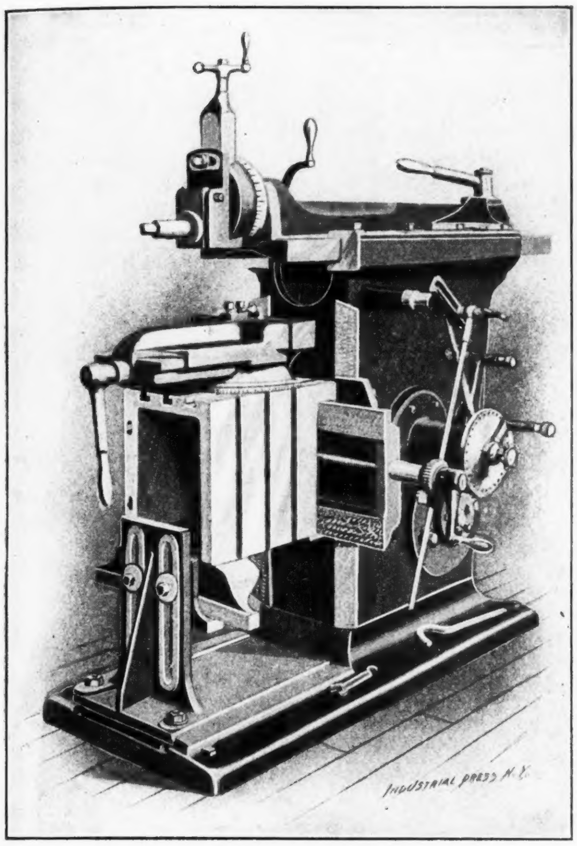


Fig. 2. New Prentiss Shaper.

novel steadying device for the table is furnished in the way of a knee, shown at the lower front part of the machine, which may be clamped to the table in any position in which it is set. This offers the advantage of great rigidity for taking heavy cuts. The change of stroke in this machine is accomplished while it is in motion, by the small crank shown at the side, the quick return being obtained by a link motion placed in the column of the base. The gearing in all sizes of the shaper is made very strong, and the driving cones are arranged for abundantly large belts. The hollow construction of the base under the ram permits of cutting keyways in bars or shafts by passing same through the hollow under the ram.

IMPROVEMENT IN GISHOLT LATHE.

In Fig. 3 is an illustration of a 24-inch Gisholt turret lathe, such as is exhibited at Buffalo by the Gisholt Machine Co., Madison, Wis. It is direct-connected to a "Northern" motor.

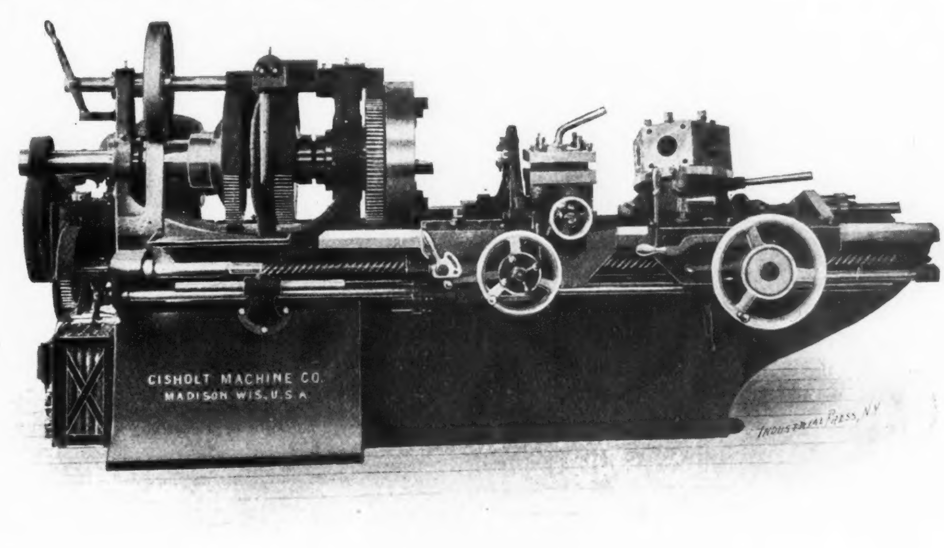


Fig. 3. Gisholt Turret Lathe.

A new feature of the lathe is a simple device for moving the turret back and forwards by power, through the action of a hand lever. The lathe is equipped with both a carriage and turret and in case the turret has been used and the next operation is to be done with the carriage, the operator need simply to throw in the lever and the turret will move back to the proper place and the driving mechanism will be thrown out automatically. The operator, therefore, can continue working with the carriage without having to pay any attention to the turret. As the tools on the turret are arranged so that the turret is well balanced it is an easy matter, after starting the turret to move backward, to revolve the turret while the slide is in motion. In this way no time is lost in performing this operation, and as the turret can be moved back and forth at a high rate of speed, considerable time can be saved as compared with the hand traverse.

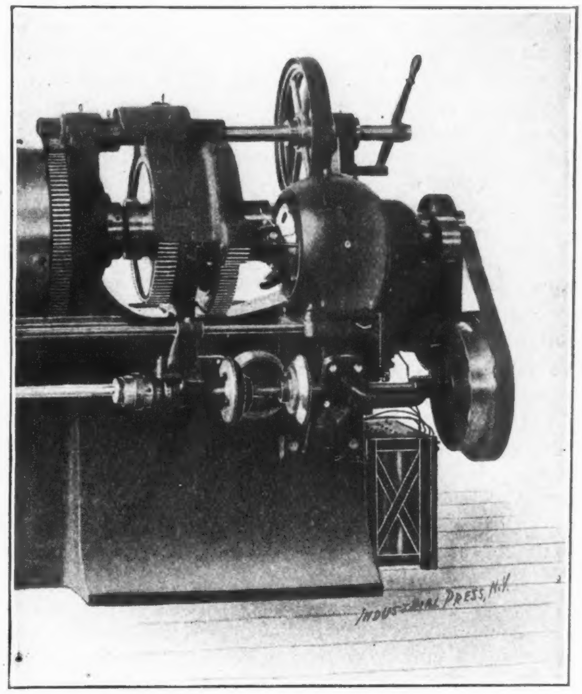


Fig. 4. Motor Arrangement of Lathe.

The machine at Buffalo is equipped with the tools for finishing a commutator, and which show the advantage of being able to operate the carriage and turret simultaneously. A Gisholt tool grinder is also on exhibition in which the wheel is driven by a motor placed on the wheel shaft. The motor is dust proof and the arrangement is found very satisfactory.

NEW VERTICAL MILLING MACHINE.

A vertical milling machine has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., two views of which are shown in Figs. 5 and 6. One of the first machines of this design that was built is now on exhibition in the space occupied by this company at the Pan-American Exposition.

The general style of the machine and design of frame are evident from the illustrations. The spindle has a hole its entire length and runs in bronze boxes. The lower box is provided with means of compensation for wear, and the

driving pulleys run on phosphor bronze sleeves instead of directly upon the spindle, thus relieving the latter of belt pull. Twelve spindle speeds are obtained, varying from 85 to 1,260 revolutions. These changes are obtained by two countershaft speeds in conjunction with three steps on the cone at the back of the machine, and two other speed changes through a special arrangement of belts for driving the spindle. The main belt passes from the cone shaft at the rear of the machine and drives the large pulley on the spindle, which gives one of the speeds. The other one is obtained through two auxiliary belts, one of which runs from the large spindle pulley to the double pulley on the vertical shaft at the rear of the column. This belt passes underneath the main belt, the latter riding upon it as it passes over the large spindle pulley. The other auxiliary belt runs from the upper pulley on the vertical shaft to the small pulley on the spindle. By an arrangement enabling the large spindle pulley to be disconnected so that it will run freely, and the small one made fast to the spindle, the latter can be driven at a high rate of speed through the two additional belts.

The vertical shaft at the rear of the machine also serves to drive the feeding mechanism for the table. This mechanism, shown at *A*, Fig. 6, is new in design. The various changes can be easily obtained by the movement of the hand lever *B*. The lower cone of gears in this mechanism is driven from the vertical shaft through bevel and spur gears and an upper cone of six gears behind the index plate is driven through an intermediate gear held by a yoke at the lower end of the controlling lever, *B*. To change the feed it is only necessary to unlatch the lever and slide it along to the desired feed plainly indicated on the index plate, and latch it into position under the feed indicated. The feed is carried from this mechanism to the table through spur gears and a universal joint.

The small lever *C* at the top of the index plate is for quickly changing the feed from fast to slow, or *vice versa.* This lever controls a clutch that engages gears on the shaft

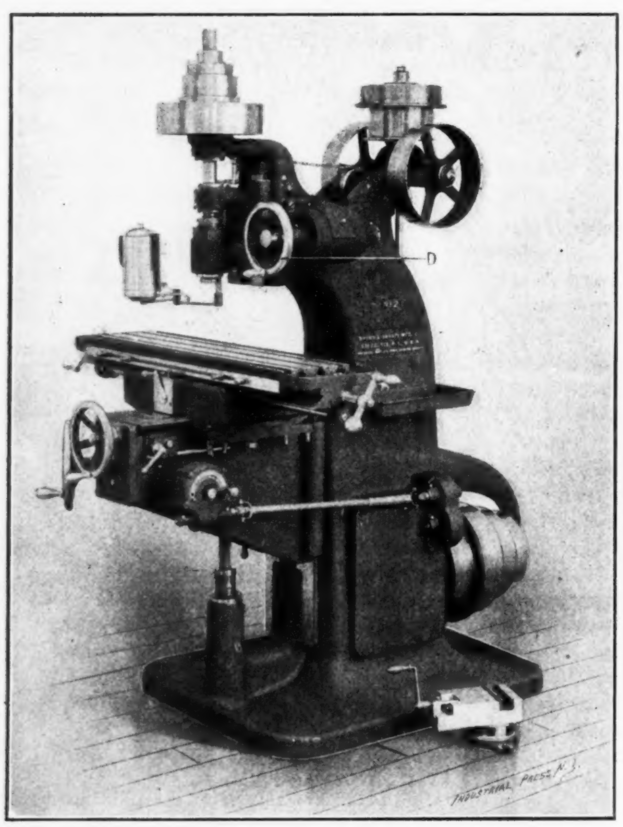


Fig. 5. Brown & Sharpe Vertical Milling Machine.

which drives the universal joint. It is possible to obtain twelve feed changes ranging from 0.005 to 0.125 inches to one revolution of the spindle. There is a fine hand feed and a quick return for the spindle head, both of which are operated by one handwheel shown at *D*, through a differential mechanism that will give either the slow or the rapid motion. This is a simple and novel feature, enabling the machine to be used as a drill press for work already in position for milling. A micrometer stop, shown at *E*, is graduated to thousandths of an inch, and controls the depth of the cut.

The lower end of the spindle has a No. 10 B. & S. taper hole and cutters and arbors are held by a bolt passing through

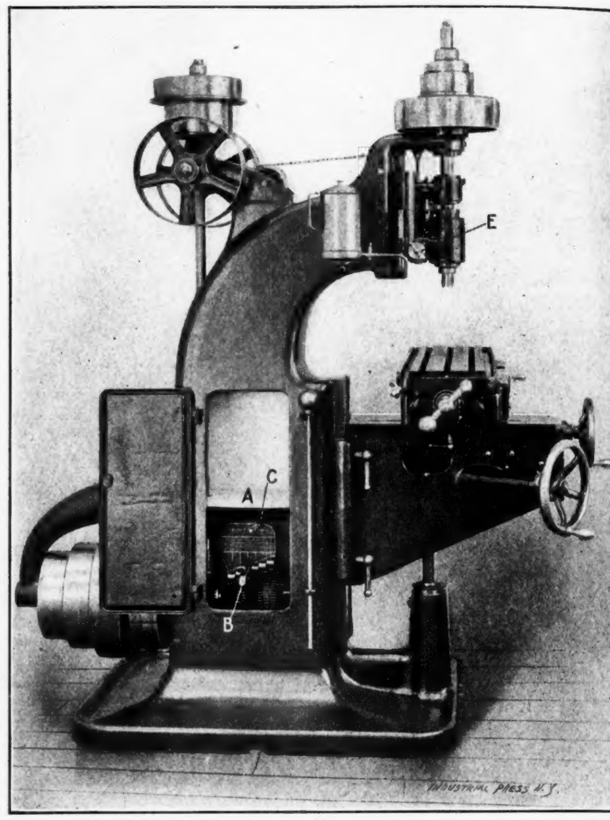


Fig. 6. View showing Feed Gears.

the spindle. The distance from the center of spindle to column is 16 inches, vertical movement of head, 4 inches. The table is 45 inches long, 10¼ inches wide, has a transverse feed of 12 inches, and can be lowered 16 inches from the end of the spindle. The longitudinal feed is 26 inches.

MOTOR-DRIVEN VERTICAL DRILL PRESS.

The accompanying cut, Fig. 7, on the next page, illustrates a 48-inch vertical power-feed drill press, with direct-connected electric motor, which Gould & Eberhardt, Newark, N. J., have just furnished to the United States Navy Yard at Norfolk, Va. This machine, which is the fifth drill press they have furnished to this yard, is fitted with the Eberhardt automatic tapping attachment, shown at the left of the drill spindle. This attachment is used for tapping up to 1½ inch, and work after being drilled may be rapidly moved across and centered under the tap by means of the compound traverse table. The drive is fitted with friction clutches, shown at the rear of the machine, to obtain right or left motion for the drill spindle, for large tapping. Straight belts are used for this, instead of the usual crossed belts, the necessity for a crossed belt being overcome by a reverse pulley shaft, in addition to the driving pulley mounted on the armature shaft of the motor, which is coupled to the armature shaft by a pinion at its end.

The portable compound chuck shown at the top of the drill table is used in connection with the drill press for vertical profiling or milling dies, punches, cams and other irregular shapes, and reduces the necessity of a special machine for that purpose. The table and base plate are large and sufficiently braced to maintain perfect rigidity for the machine. The column is practically one casting, and together with back brace forms a very strong construction, the back brace to the column counteracting the pull of the cone belt and thus preventing any possible springing or deflection. An index is placed on the feed rod, which tells at a glance the proper feed for any size drill within the range of the machine. This feed is entirely independent of the drill spindle, and changing the speed of the drill does not affect the feed

arrangement. Also an automatic stop and depth gage throws out the feed after drill has reached the required depth. The back gears are arranged so that one movement of a lever releases the cone from the shaft and engages the gearing, and changes the feed ten times coarser, while one movement in the opposite direction disengages the gearing. The spindle head is vertically adjustable, and can be raised or lowered and clamped in position. A square quill is used in place of

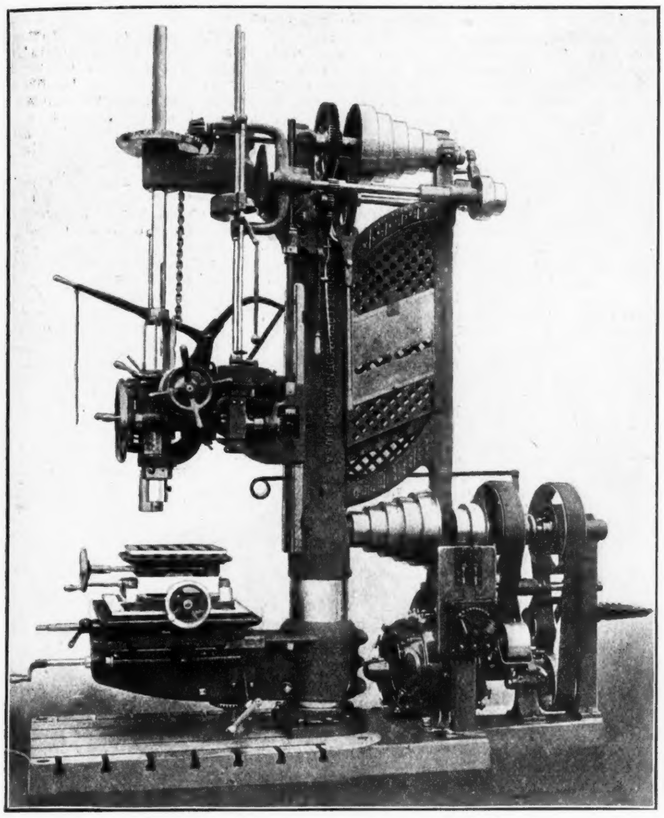


Fig. 7. Eberhardt Drill Press.

the usual round sliding barrel, which adds to the rigidity of the spindle in boring deep and rough holes. Feeding can be done automatically, or by hand, up or down, separately through the head the entire length of planed surface on the column, or independently through the rack on the quill. All changes are made from the front of machine, thus allowing the operator to remain in the one position, directly before his work.

COMPRESSION SHAFT COUPLING.

A novelty in the way of a compression shaft-coupling is shown in the accompanying illustrations, Figs. 8 and 9. Fig. 9 shows the parts of the coupling separated and Fig. 8 shows them assembled as they appear when in use. The coupling consists of a coupling proper, which resembles a pulley with its hub split into three parts, to allow each being forced inward against the shafting. A small amount of radial motion is permitted in these parts of the hub by the peculiar arrangement of the spokes shown in Fig. 9, the spokes being set tangentially to the hub instead of radially. The outside of the hub is turned off tapering on each end and compression collars, or flanges, shown also in Fig. 9, are turned to fit snugly on their tapering ends. Then, when it is desired to use the coupling, the coupling hub is brought over the joint in the shafting and the compression flanges drawn together up over the hub ends, by the bolts shown, which wedges the hub sections firmly upon the shaft. Thus the coupling is effected by the friction due to the intense pressure upon the shaft, and no keys are required, which is a great convenience, as it can be ordered and put up without any extra fitting. The coupling is manufactured by the W. P. Davis Machine Co., Rochester, N. Y.

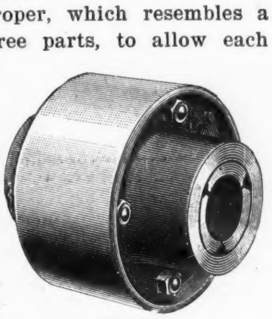
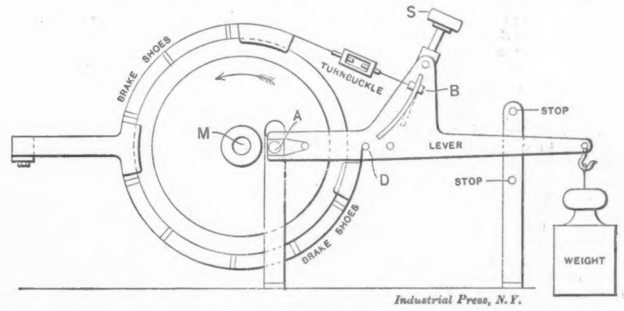


Fig. 8.

NEW PRONY BRAKE.

The *Mechanical World* describes a new Prony brake which is in use in the works of Siemens & Halske, Charlottenburg, Germany. The lever arm is pivoted at *A*. The band carrying the brake blocks is connected to the lever at *D* and *B*. The brake blocks are hollow and provided with internal water circulation for cooling. The faces of the brake shoes are smeared with tallow, and no water is allowed on the friction surfaces. The block *B*, to which the band is attached, moves in a curved slot, being controlled by the screw and handwheel *S*. A turnbuckle is provided in the band for



tightening the grip of the blocks. A very close regulation may be obtained by means of the various adjustments, since the coefficient of friction fluctuates very slightly owing to excellent lubrication and absence of water from the friction surfaces. It is necessary that the center *M* of the shaft, the pivot at *A* and the point of attachment of the weight to the lever all be in the same straight line parallel to the ground line.

* * *

The Hamburg-American steamer *Deutschland* sailed from New York July 11 and arrived at Plymouth July 17, making the trip in 5 days, 11 hours and 5 minutes. While this is not the quickest trip made by the *Deutschland* between Sandy Hook and Plymouth, it is the best record for the long course. On this trip she made an average run of 23.51 knots an hour.

* * *

PAN-AMERICAN SEARCH LIGHT SIGNALS.

Signals from the 30-inch search light, on the Electrical Tower of the Pan-American Exposition, were sent to Niagara Falls, July 25th, by Prof. Geo. F. Sever, Superintendent of Electrical Exhibits, in the presence of the electrical jury, thus demonstrating the feasibility of this method of signalling at night.

Since that time search light signals have been sent from Buffalo to Toronto, a distance of 58 miles, through arrangements completed by Prof. Sever in co-operation with Mr. Wm. S. Aldrich, consulting electrical engineer, of Toronto. The first trial was made on the evening of August 9, with clouds over Toronto. The local illumination of the overhead sky by the electric arc light in the streets of Toronto effectually prevented any discrimination being made between the local and the Buffalo illumination of the clouds. The second trial was made on the evening of August 13, with a

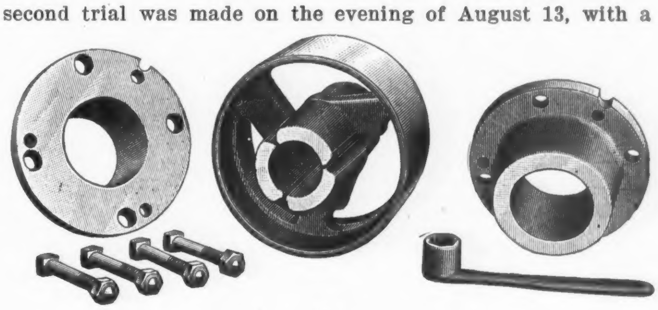


Fig. 9.

perfectly clear atmosphere. Owing to the smoke settling down over the city, no signals could be discerned from the top of the Municipal Hall Tower, Toronto. This was the prearranged objective point for both experiments.

Special long-distance communication was arranged between the top of this tower and the Electric Tower, at the Pan-American, through the courtesy of the Bell Telephone Co., of Ontario, represented by Mr. K. J. Dunstan, of Toronto, so that every detail of the experiment could be followed. The

special instructions were to depress the search light to the lake horizon, bearing on the Municipal Hall Tower, Toronto, then to sweep the horizon a definite angle, to the right and left of this bearing, and later to elevate and depress the light at the original bearing. All of these signals were very clearly discerned during the second trial two miles off shore from the city.

* * *

FRESH FROM THE PRESS.

THE TEXTILE WORLD'S OFFICIAL DIRECTORY FOR 1901. Published by Guild & Lord, 620 Atlantic Avenue, Boston, Mass. Price, linen-covered edition, $2; bound in cloth, $2.50.

This is a most valuable work of reference to everyone interested in the textile industries, and is divided into five parts, as follows: Part I.—Textile Manufacturers. Part II.—Agents and Buyers of Textile Fabrics. Part III.—Dealers in Raw Materials. Part IV.—The Yarn Trade Index. Part V.—Classified Lists of Commission and Order Mills, Dyeing and Finishing Establishments, etc.

All the textile establishments in the United States are arranged by location alphabetically under States, Cities and Towns, with maps showing the location of the textile mill cities and towns in the principal manufacturing states. The 1901 edition contains a yarn index, commission mill list, shoddy mills, and many pictures of mills—all features of value and interest to those in the textile trades.

The directory is in every sense an original work, all the firms represented being verified by actual personal and mail canvas, so that no "dead timber" is represented. Every effort has been made to have it correct in all details and to insure its accuracy a reward is offered for the first discovery of all omitted firms.

A HAND BOOK FOR APPRENTICED MACHINISTS. Edited by Oscar J. Beale. 141 16mo pages, bound in cloth, fully illustrated. Published by Brown & Sharpe Manufacturing Co., Providence, R. I. Price 50 cents.

This book was primarily issued for the instruction of the apprentices in the shops of the Brown & Sharpe Manufacturing Co., but until the appearance of this edition had never been published. It has been issued to the public in response to the general call for a work of this character from the apprentices and others in the machine shops of the country. It may also be read with profit and interest by almost any experienced machinist.

The various subjects are: Care of Machines, Tools and Work; Centering and Care of Centers; Turning, Reading Drawings, Measuring, Lacing Belts; Signs and Formulas; Drilling, Counterboring, Tapping, Cutting Speed; The Screw and its Parts; Figuring Gear Speeds; Figuring Pulley Speeds; Change Gears for Screw Cutting; Angles. Setting a Protractor, Working to an Angle; Circular Indexing; Straight Line Indexing; Subdividing a Thread, etc.

The subject matter is treated in a plain and simple manner, which makes it easily comprehended by anyone of ordinary education. It is a book that should be popular with young machinists, as we know of no reliable work of a similar character which contains so much mechanical information gotten up in convenient form to sell at so low a price. It would undoubtedly be a profitable investment for many of the large machine building firms throughout the country to place this book in the hands of their apprentices, as in no other way could they impart to such employees so much reliable information at so little expense.

ADVERTISING LITERATURE.

We have received the following catalogues and trade circulars:

WALWORTH MFG. CO., Boston, Mass. Pamphlet of the Van Stone pipe joint. This is a pipe joint without threads or rivets, and is adapted to extremely high pressures.

STOW MFG. CO., Binghamton, N. Y. Catalogue No. 9, descriptive of the Stow flexible shaft, and the Stow multi-speed electric motor. Illustrations are shown of many applications of both.

ROCKWELL ENGINEERING CO., New York City. Catalogue of furnaces for the heating of metals or any other materials by use of any desired kind of fuel. A specialty is made of oil or gas annealing and hardening furnaces.

BUFFALO FORGE CO., Buffalo, N. Y. Pamphlets of the Buffalo disk wheels for ventilating, cooling and drying, and steel pressure blowers for all service requiring high pressure air blast.

NORTHERN ENGINEERING WORKS, Detroit, Mich. Catalogue No. 50, descriptive of the Newten cupola. The features of the new design and their patented tuyere system are described.

FRANKLIN MACHINE WORKS, Philadelphia, Pa. Catalogue of plain milling machines, cold saw cutting-off machines, automatic saw sharpening machines and horizontal boring machines.

EMPIRE ENGINE AND MOTOR CO., Orangeburg, N. Y. Catalogue No. 2, descriptive of their Empire air tools, including pneumatic chain hoists, drills, reamers, center grinders, crane motors, winches, etc.

NEW HAVEN MFG. CO., New Haven, Conn. Catalogue illustrating their iron planers, engine lathes, drilling machines, slotting machines, boring mills, and automatic turrets.

LEWIS TOOL CO., New York City. Catalogue No. 6, descriptive of the Lewis double steel sliding bar vises. These vises are made in all styles of adjustable back jaw, swivel base, self-adjusting, quick-acting, etc.

AJAX MFG. CO., Cleveland, O. Ajax red book, descriptive of Ajax upsetting and forging machines, bolt heading and rivet making machines, bulldozing and bending machines, nut machines, and nut-tapping and bolt-threading machines.

WILMARTH & MORMAN CO., Grand Rapids, Mich. Catalogue descriptive of the New Yankee drill grinder, and a folder descriptive of the Wilmarth friction countershaft, which was recently described in these columns.

BECKER-BRAINARD MILLING MACHINE CO., Hyde Park, Mass. Catalogue No. 53 of vertical milling machines. The advantages of vertical spindle milling machines are outlined and numerous views of its work are shown by photographs.

THE ANDERSON TOOL CO., Anderson, Ind. Catalogue of the Lea electrically-driven universal grinders. The headstock spindle and the grinding heads are each direct driven by separate motors, which allows the greatest flexibility.

J. T. SLOCOMB & CO., Providence, R. I. Catalogue of machinists' tools, comprising micrometer calipers of all sizes, tube and screw thread micrometers, special micrometers, depth gages, standard end measures, etc.

THE CHICAGO FLEXIBLE SHAFT CO., Chicago, Ill. Illustrated catalogue of the Stewart gas blast furnaces and rotary pressure blowers. A very complete line of gas furnaces is presented, including muffle furnaces, crucible and forge furnaces, case-hardening and annealing furnaces, and automatic furnaces for a great variety of work. A novel tempering furnace is described, in which a crucible of melted beef-tallow is used for drawing tempers. The melted tallow may be maintained at any desired temperature by keeping a pyrometer suspended in it, and thus the temper to which a tool will be drawn is reduced to an absolute certainty.

MANUFACTURERS' NOTES.

THE NORWALK IRON WORKS CO., South Norwalk, Conn., are adding a large foundry to their establishment.

MR. FREDERICK BROTHERHOOD has been appointed manager of the foreign sales department of the Railroad Supply Co., with headquarters at their New York store, 106 Liberty St.

SAM LAGERLOF, importer and exporter of tools and machinery, Stockholm, Sweden, announces that he has started a machine bureau, and is open for all quotations for all kinds of machine tools, and wishes to receives catalogues relating to same.

THE PHILADELPHIA MACHINE TOOL CO., Philadelphia, Pa., inform us that Mr. Gus. C. Henning, the well-known engineer and specialist on testing of metals, has made them sole agents for his apparatus, which they will handle with their regular testing machine business.

THE STANDARD TOOL CO., Cleveland, O., have just issued their new Red Shield catalogue for 1901. This illustrates many entirely new tools, and contains some useful tables and general information and a very convenient telegraphic code. It also contains price lists covering all the regular sizes, with a complete index at the end.

THE KILBOURNE & JACOBS MFG. CO., Columbus, O., announce that they have recently issued several new catalogues, as follows: No. 7, No. 31, and No. 33, illustrating vehicles of all kinds for transporting baggage and freight. Among these are skids, mine, mill and industrial cars, dump cars, wheelbarrows of all kinds, etc.

THE SCRANTON CORUNDUM AND EMERY WHEEL CO., Scranton, Pa., are now occupying a new factory and office building which they have recently erected on Capouse Ave., Scranton. A feature of their abrasive wheels is that they are so designed that it is impossible for a wheel to burst in a way to result in injuries to the operator.

THE WILMARTH & MORMAN CO., Grand Rapids, Mich., state that late in July they received in one day orders for fourteen "New Yankee" drill grinders, several for export, and four machines for the U. S. government. They also state that Baker Bros., Toledo, O., have contracted with them to furnish the Wilmarth friction clutch on their line of keyseaters.

THE BINSSE MACHINE CO., Newark, N. J., successors to the Newark Machine Tool Works, have been awarded the contract for the entire horizontal boring machine equipment of the British Westinghouse Co., Manchester. The present order consists of three 6-foot table machines and three large double-head machines for boring the street car motor frames.

MR. JAMES C. HEMPHILL, formerly in the employ of C. B. Cottrell & Sons Co., Westerly, R. I., announces that he has started in business under the firm name of the Rogers & Hemphill Machine Co., Alfred, N. Y. This firm will be engaged in the manufacture of machine tools, and at present they are making a specialty of vertical boring and turning mills. The Prentiss Tool and Supply Co., New York, are their selling agents.

THE NEW PROCESS RAW HIDE CO., Syracuse, N. Y., have received a contract from the United States Mint, Philadelphia, for six New Process noiseless pinions 16 inches diameter, 6 inches face. These pinions are a part of the equipment of the new mint building, the machinery for which is just being installed. They are to be used for transmitting power from a 50 horse power motor to a 10-inch by 9-inch rolling mill, and will run 175 R. P. M., meshing into a 60-inch iron gear. Six armature pinions for the same motors were also shipped by the company recently. They are 12 2-3 inches diameter, 4 inches face, and will run at a speed of 525 R. P. M. The company has just made a shipment of 24 pinions to the Sao Paulo Light and Traction Co., Sao Paulo, Brazil.

MANNING, MAXWELL & MOORE, New York, inform us that Mr. Walter M. Wood, formerly associated with the Niles Tool Works, has now accepted a position with them and will represent Manning, Maxwell & Moore, operating from their new store, 128 Oliver St., Boston. Mr. G. E. Randles, formerly with the Pratt & Whitney Co., Hartford, is now representing Manning, Maxwell & Moore at their Philadelphia office; and Mr. David Hunt, Jr., formerly connected with their New York office, is now representing them at the Cleveland office, located in the Williamson Building.

THE BUFFALO FORGE CO., Buffalo, N. Y., have, in addition to their chief exhibit at Machinery Hall, several other installations on the Pan-American Exposition grounds. In the building designed for the Buffalo Historical Society they have installed a complete fan system apparatus for heating and ventilating, the fan being so made as to give a complete change of air every ten minutes. In the service power houses they have placed a 17 x 28 x 18 Buffalo horizontal tandem compound engine with automatic flywheel governors and self-oiling system. Also a Buffalo mechanical induced draft apparatus. In the Electricity Building they installed two 80-inch down-blast steel plate fans driven by induction motors.

CHARLES H. BESLY & CO., 10 and 12 N. Canal St., Chicago, Ill., report that they are receiving many orders for chucks, vises, power hack saws and general supplies. They state that they have never sold as many Gardner grinders and Besly band machines as at the present time, recent shipments having been made to New York, Pennsylvania, New Jersey, Massachusetts and Rhode Island. They call special attention to their new spiral paper circles to be used on Gardner grinders. They are now able to produce abrasive circles suitable for work on steel, cast iron, drop forgings, malleable iron, aluminum and the alloyed metals, gutta percha and wood. Samples of these new circles for trial will be sent to users of their machine without charge. When ordered, state metal to be ground.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., wish to call attention to the fact that they will withdraw their offer of a free scholarship on September 30 next. This free scholarship is an excellent opportunity for the ambitious mechanic to obtain a technical education. This school makes a specialty of steam, electrical and mechanical engineering, heating, ventilating and plumbing, and mechanical drawing. They state that the courses have been carefully laid out by prominent educators and engineering experts, and embrace every subject required by the up-to-date engineer and mechanic to master the theoretical details of his daily work. The tuition has been placed low, so that no mechanic shall be debarred from receiving the benefit of the course. A handbook describing the School's methods and courses will be sent to any one on receipt of a postal card request.

THE NICHOLSON FILE CO., Providence, R. I., announce that they have purchased of the J. Barton Smith Co., Fourth and Somerset Sts., Philadelphia, Pa., the file and rasp manufacturing business heretofore carried on by them in that city, including all of the machinery, tools, stock of goods, patents and good-will of that company. Payment should be made to the J. Barton Smith Co., Philadelphia, Pa., for all charges by them prior to August 1, 1901. Remittances for all bills of files and rasps rendered on and after August 1, 1901, as well as all orders, should be sent direct to the Nicholson File Co., Providence, R. I. They solicit the continued patronage of all those who have handled the file and rasp products of the J. Barton Smith Co., assuring them that the quality of these goods will be maintained in every particular, and that their business shall receive their prompt, careful and courteous attention.